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CONTENTS

Frank J. Pieneisel ..... F. J. Schneiderhan 129
The problem of Dichrostachys nutans, a weed tree, in Cuba, with remarks on its pathology ..... James R. Weir 131
Plant disease notes from the Central Andes. Carlos E. Chardón and Rafael E. Toro 147
The nature of seed-piece transmission of potato blackleg. J. G. Leach 155
Uniformity of nomenclature for the viroses of Solanum tuberosum. Donald Folsom 161
A study of the distribution of Tilletia tritici and T. laevis in 1926. W. H. Tisdale, C. E. Leighty, and E. B. Bonnell 167
Experiments with dusts for controlling stripe disease of barley. R. W. Leukel, James G. Dickson, and A. G. Johnson 175
The occurrence of Blakeslea trispora Thaxter in the Dutch East Indies ..... S. C. J. Joosten 181
Apple blotch canker eradication ..... Max W. Gardner 185
A modified method of delinting cotton seed with sulphuric acid. C. D. Sherbakoff 189
Photographing living conidia mounted on agar ..... C. D. Sherbakoff
Control of internal rot of caprified figs ..... H. H. Hansen 199
Fungicidal value of oil sprays ..... Frank P. McWhorter 201
Book Review 209

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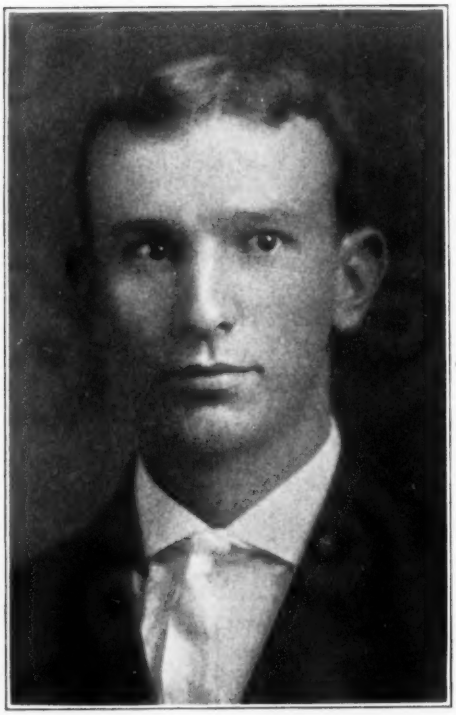

FRANK J. PIEMEISEL

PHYTOPATHOLOGY

VOLUME 17 NUMBER 3

MARCH, 1927

FRANK J. PIEMEISEL
1891–1925

F. J. SCHNEIDERHAN

In the death of Frank J. Piemeisel the phytopathological world lost a young man whose talents gave every indication of future leadership in his chosen work. He was born at Jordan, Minnesota, June 30, 1891, and died November 24, 1925, at St. Cloud, Minn.

His elementary training was given him in the common schools at New Prague, Minnesota, from which he entered high school at Jordan, Minnesota, graduating in 1909. Before entering college he taught one term in a country school. In September, 1911, he entered the freshman class in the Forestry School of the University of Minnesota but at the end of this year changed to the Agricultural College. He was working his way through college and found work as assistant in the greenhouse laboratory courses in horticulture and agricultural botany. In his junior year he decided to make plant pathology his life work. He graduated from the University in 1914 with the degree of Bachelor of Science in Agriculture. His record during his undergraduate days was an excellent one, and he became a marked man for research work in plant pathology. He was honored at graduation by the award of the Shevlin Fellowship, which gave him the sum of $600 and free tuition in the Graduate School, which he entered in the fall of 1914. In June, 1915, he obtained the M.S. degree. He was then employed by the Office of Cereal Investigations, Bureau of Plant Industry, where his research work stamped him as an outstanding investigator. He had made arrangements to pursue graduate work for his doctorate when he was drafted into the army on September 20, 1917, and was sent to France with the Meteorological Section of the Signal Corps. Piemeisel was in the first group of select men who went to war from his native town of Jordan. After serving 13 months overseas, he returned to the United States in February, 1919, utterly incapacitated for any type of work: the blight of

war left its tragic imprint on him, both physically and mentally. He received medical treatment at his home in Jordan and at Rochester, finally being sent to the Veterans' Bureau Hospital at St. Cloud, Minnesota, where he died of tuberculosis. Special memorial services were conducted in the auditorium of the Jordan High School, with speakers from the Minnesota State headquarters department of the American Legion. His funeral was a military one; the pall bearers were men who had served with him overseas.

Frank Piemeisel was a man of retiring disposition, and of the finest type of mentality. Even as an undergraduate he was far above the average of his classmates. He was endowed with a splendid memory and, although practically all of his studies were in biology, he possessed mathematical ability of a high order. He was a serious-minded student in whom the desire and joy of study was inborn. Never a pampered individual in boyhood, he grew up as a versatile, self-reliant student and scientific investigator whose untimely death was to his classmates and scientific associates one of the war's saddest casualties.

He was a fellow of the American Association for the Advancement of Science, a member of Sigma Xi and of the honorary agricultural fraternity of Alpha Zeta.

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1914

Some facts of the life history of *Ustilago zeae* (Beckm.) Unger (Abs.) Phytopath. **4**: 411.

1916

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1917

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Biologic forms of *Puccinia graminis* on wild grasses and cereals. (With E. C. Stakman). Jour. Agr. Res. **10**: 429–496. (Prelim. report) Phytopath **6**: 99–100.

1918

Can biologic forms of stem rust on wheat change rapidly enough to interfere with breeding for rust resistance. (With E. C. Stakman and J. H. Parker). Jour. Agr. Res. **14**: 111–123.

Plasticity of biologic forms of *Puccinia graminis*. (With E. C. Stakman and M. N. Levine). Jour. Agr. Res. **15**: 221–249.

THE PROBLEM OF DICHROSTACHYS NUTANS, A WEED TREE, IN CUBA WITH REMARKS ON ITS PATHOLOGY

JAMES R. WEIR

INTRODUCTION

In 1919 the writer's attention was called to the growing menace of the weed tree, *Dichrostachys nutans* (Pers.) Benth., on the arable lands in Cuba. At that time a report was prepared on certain fungi found on dead branches of the tree submitted for examination by Dr. Emilio D. Cassi, of Havana. This material was collected in a "Marabusal" of some 40 caballerias (about 1,350 acres) in which a disease was said to exist. Dr. Cassi in his letter described the disease as follows: "The bark at the base of the trunk turns a dull black, detaching itself from the tissues of the Marabon, while its roots and rootlets become fully rotten. I would state that the blight begins in the top of the tree and gradually descends to the roots." From what the writer has recently determined in the field the above statements are significant.

The following is quoted from the writer's original report: "Three common tropical fungi were found on the specimens submitted and are responsible for the decay in the wood. They are *Polystictus pinsitus, Trametes rigida* and *Corticium portentosum*. These fungi are not parasitic and are secondary to and follow the true causal agent of the disease." Nothing more was learned on the subject until the writer's visit to Cuba under the direction of the Tropical Plant Research Foundation in November, 1924.

THE TREE

Dichrostachys nutans, or marabu, is a small tree belonging to the Leguminosae indigenous to Africa and Asia. It is said to have been introduced in Cuba from Senegal as an ornamental. The tree has the habit of some Acacias and Mimosas and has been referred at different times to *Mimosa, Desmanthus* and *Caillica*. The last, according to Macbride (2), is the first generic name used for the plant. The name for the tree is then *Caillica glomerata* (Forsk.) Macbride. Regarding this name change, Macbride states that, notwithstanding Forskal's meagre characterization of his plant, it is obvious that he was naming the species later known as *Dichrostachys nutans*, since this is the only member of the Mimosidiae growing in Arabia which has "Folia bipinnata" and "Legumen nigrum controto-globosum."

The resemblance of the tree to species of native *Acacia*, in particular to

FIG. 1. Road through dense impenetrable growth of marabu. Area previously under cultivation.

Acacia farnesiana (aromo amarillo), has led to the belief in Cuba that more than one species of *Dichrostachys* exists. Likewise the common name of *Acacia farnesiana* is often applied to the marabu. In many parts of Santa Clara province the common name of aromo or aroma was used exclusively. Roig (4) has pointed out the characters of the two species.

STATUS OF THE PROBLEM

Although the importance of marabu as a pest was learned from correspondence, it was a matter of surprise to find that it was even more serious in many localities than was anticipated. In the provinces of Matanza, Santa Clara, and Havana, the tree is abundant. It occurs in Pinar del Rio and was observed in Camaguey and Oriente. The tree is especially abundant in Santa Clara province. Brother Leon, in a letter in 1919, very aptly described the situation, and the writer's observations and photographs verify his remarks. "The tree grows so dense that the branches meeting at 5 or 6 meters above the ground cause the roads and paths cut through

to appear as tunnels (Fig. 1). The dense verdure sometimes extends for hundreds of meters uninterruptedly. From a neighboring hill it appears somewhat like a lawn or like Bermuda grass, and, sparkling as it does with handsome flowers, forms one of the most beautiful features of the Cuban Flora." In the Trinidad Valley and in the region surrounding Cienfuegos the tree is unchecked and forms veritable forests on hill land or on areas on which cane growing has been discontinued (Fig. 3). In the early stages of the formation of these forests the tree forms thickets quite impenetrable on account of density and the abundance of the long, stiff, sharp thorns (Fig. 3). Later, with increasing size of the trees, the natural pruning of the lower branches and the dying-out of the suppressed individuals, it is possible to walk over the area without much difficulty. In the fully mature stands where the trees have attained diameters from 4–6 inches the lower branches have fallen away in some cases so that it is even possible to ride through the thickets on horseback, but trails are necessary for easy progress.

Mr. H. A. van Herman (5) calls attention to the pest, stating that "whole farms in central Cuba have been rendered useless by this foreign nuisance without any effort being made to check the curse and that good farm land is being abandoned in disgust."

Whenever cane land fails, from one cause or another, to produce the required tonnage, it is frequently allowed to run wild or revert to pasture. On such areas, owing to the treatment the soil has received, the marabu finds optimum conditions for growth. Small patches of the tree make their appearance here and there over the area. From these centers the tree spreads in all directions by means of the advancing horizontal root system and by means of the seeds. The distribution of the tree is probably effected in part by cattle carrying seeds in their hoofs when driven or transported over the island. Cattle also greatly relish the seeds, and it is possible that they are capable of germination after passing through the animals.

Marabu has a well developed tap root which in good soil penetrates to a considerable depth. Lateral horizontal roots extend unusual distances in all directions. In addition there are supporting roots at an acute angle to the tap root and frequently many fibrous roots. The lateral or horizontal roots may lie at varying depths but are usually only a few inches below the surface of the ground. They may be pulled up for a distance of several feet. It is these roots that make eradication difficult. If the parent tree is cut down, these roots at once sprout profusely. If their removal is attempted, any small section left in the soil immediately develops fibrous roots and produces shoots. It was observed on areas where the parent trees were felled that the prolific development of young plants from the lateral roots

FIG. 2. Forest of marabu being cleared by slashing and burning. Old tree in the foreground apparently killed by *Ustulina zonata*.

was greatly stimulated. The ground on such areas soon becomes carpeted with small plants, and the whole on examination will be found to spring from the wide-flung root system of the parent tree. Root grafting is common between different individuals in a dense stand. It is easy to imagine that there may well be a common root system for the stand as a whole.

ERADICATION

Individual plants may be effectively killed by the application of crude petroleum to the roots. It is said that this treatment causes the death of the entire root system and that the odor of the petroleum may be detected in the roots at their farthermost extremities. This is somewhat contrary to the usual expectation and should be thoroughly tested. The petroleum should not be too thick, otherwise it will not penetrate either the soil or the roots. Salt, kerosene, and sodium-arsenite have been used effectively in barberry eradication and would no doubt be equally effective in killing marabu. The last, however, is extremely poisonous and care should be taken in its use. Individual trees also may be killed by girdling with a gasoline blow torch. The writer (6) has used this method of killing trees

FIG. 3. Dense growth of marabu on previously cultivated land, showing the dense crown canopy and young sprouts.

in the North and found it to be effective and time-saving. A torch may be devised by which a small tank may be carried on the back and connected with the burner by means of a hose and short length of rigid tubing.

After the tree is once established in pure stands the only practical means known at present of eradication over large areas is by slashing and burning (Fig. 2). This is done at considerable expense, and only a high profit crop such as sugar cane will pay for the effort. The broadcast burning of the area, however, does not destroy the root system. The ground is soon carpeted with young root sprouts. If cane is planted on the area, frequent hoeing is necessary until the cane is big enough to shade the ground. If the area is maintained continuously in cane for a protracted period and the sprouts are prevented from developing, the area may be effectively freed from the pest. Some varieties of cane are more effective in shading the ground than others. Uba cane, owing to its density, is said to prevent the growth of marabu more than any other variety.

Although it is not known to what extent the foliage of the marabu is eaten by stock, still it would appear that the young plants on a newly cleared area may be kept down by grazing goats if the land is not immediately util-

ized. After the plants have become woody and covered with thorns it is not likely that they would be eaten.

The bark and wood of the marabu contains tannin. The setting up of plants for the extraction of tannic acid may be a worthwhile consideration. In this connection, comparison is made with *Acacia decurrens*, *A. mollissima* and *A. dealbata*, the tannin-producing wattles of South Africa and Madagascar. The wood of marabu makes an excellent charcoal and is much used for this purpose. It would appear that the commercial utilization of the tree might be undertaken at a profit.

While in Cuba the writer heard of a cattle man who instructed his field staff to immediately destroy all marabu plants encountered. This resulted in his estate being free from the pest, although surrounded by a dense growth of the tree.

DISEASES OF MARABU

No further notice of a disease of marabu, after that mentioned in a letter by Dr. Cassi, came to the writer's attention until the spring of 1924. At this time Dr. W. H. Weston sent to the writer a fungus which he had collected on marabu at the central Trinidad. The fungus (*Ganoderma pulverulentum*) was found in the root crotches and also attached to the horizontal roots of dead and dying trees at the central Trinidad. Later the writer examined the same area and collected the fungus in abundance (Pl. VI, A). A close examination of the affected trees leads to the opinion that this fungus is able to attack the trees only under certain conditions, such as the presence of fire scars, wounds made by the tramping of cattle or by bark and wood-boring insects. Entering through wounds, the fungus attacks the heart wood, causing a whitish undifferentiated decay. This decay is in striking contrast with the sound, dark brown heart wood. The mycelium may follow in or along decaying horizontal roots and develop fructifications some distance from the base of the tree.

Ganoderma pulverulentum does not produce white mycelial layers in or beneath the bark. The white fan-like structure often found in association with it belongs to the fungus described here. The fructifications are of the usual Ganoderma type of the stipitate group and need not be described. The species has been described several times as new, but the name *Ganoderma pulverulentum* Murr. may be used for the present. *Polyporus opacus* Berk. and Mont., a species characterized by a light-colored zonate pileus and very rough spores, is also found on the roots of marabu. The species is rare and apparently of no importance in Cuba.

A close examination of the trees on the area where *Ganoderma pulverulentum* was found disclosed the interesting fact that the primary cause of the death of the trees was *Ustulina zonata* (Lev.) Sacc. This fungus is widely distributed in the tropics and is known to attack a large number of hosts. It is chiefly known as a cause of a root and trunk disease of coffee,

cacao, tea, rubber, and other perennial crops. The writer has recently described the fungus in detail in a report on the diseases of *Hevea* in the Amazon Valley, and only a brief account of its characteristics is necessary here.

The marabu trees attacked by this fungus begin to die gradually. The leaves turn yellow and fall. Even before the tree dies the fructifications of the fungus appear around the base or on the lateral roots (Pl. VI, B, Pl. VIII, A and B). These first appear as small pustules which enlarge, become confluent with similar structures and eventually form broad white or grayish white plates of several inches in extent (Fig. 4). During this stage conidia are produced as free spores on the surface of the plate (Pl. VII, B). The growth of the plates may be arrested by change in weather conditions resulting in concentric zonations of the surface (Fig. 4). If growth is continuous the disks may be smooth except when growing over irregular surfaces. After the procutio production of the conidia, at which time the plate is soft, it becomes hard and changes color to grayish green, then purple-black and eventually becomes quite black, hard and brittle. The surface is then covered with small black dots (Pl. VII, F). These are the openings to the peritheeia (Pl. VII, E) which produce the ascospores or second spore form (Pl. VII, D). The nature and appearance of these structures are well shown in plate VII and in figure 4.

Ustulina zonata is considered to be identical with *U. vulgaris* Tul. of the temperate zone by some authors and by reasons of priority should be referred to *U. maxima* (Weber) v. Wettst. For comparison the appearance of the average spores of the two forms are shown in Pl. VII, A, B, C and D. It would appear that the material here studied does not belong to one species.

Ustulina zonata does not form an external vegetative mycelium. If the bark is removed, a white fan-like mycelium is disclosed (Pl. VI, C, and Pl. VIII, C), which covers the surface of the wood as a continuous sheet. It is this mycelium which girdles the tree or its roots and destroys the cambium, resulting in the death of the tree. The wood is permeated with black lines, as is usually the case with fungi of this group (Pl. VIII, D). The wood of young roots may be evenly blackened by the development of the mycelium in the vessels (Pl. VIII, E). Before the tree dies or afterwards, wood-destroying fungi appear, resulting in the decay of the roots and stems.

Ustulina zonata was found at several stations in the Trinidad Valley. Only at Central Trinidad was it associated with the *Ganoderma*. The fungus was invariably found at the bases of dead trees and those with yellow foliage.

The observations show that *Ustulina zonata* attacks and kills the marabu. This being a gradual process, the use of the fungus in eradication work will be determined by future investigations. A series of inoculations have been

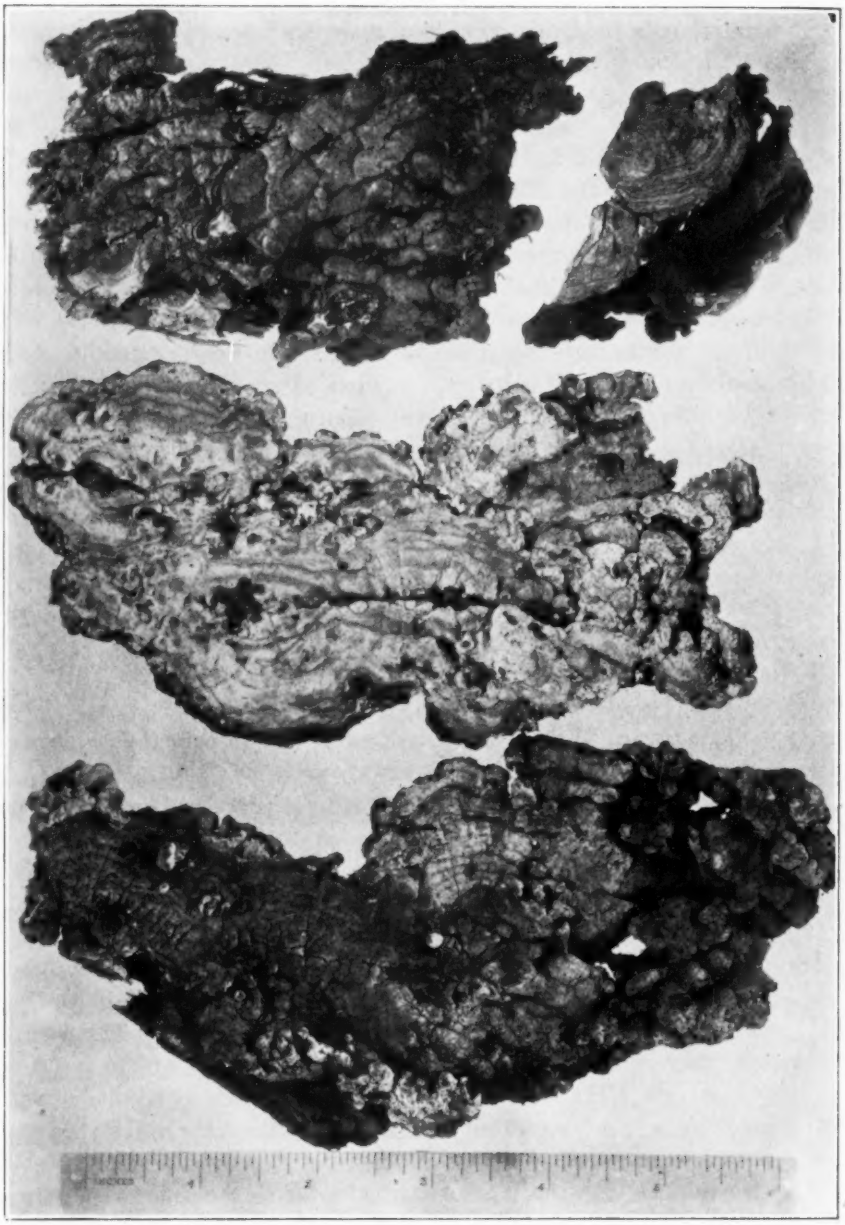

FIG. 4. *Ustulina zonata* on marabu, showing the varying form and appearance of the encrusting fructifications.

made in the field, the results of which will be reported later. Since the parasite in Trinidad Valley was especially associated with the marabu, it seems likely that we are dealing here with a special strain of the fungus which may not attack the more permanent crops of the region.

It is believed that a full and careful study of the marabu situation will result in devising a practical and rapid means of disposing of the pest. To this end more should be known of the diseases and pests of the tree in the countries where it is indigenous. A leaf-eating insect which has been determined by Dr. A. G. Böving, of the Bureau of Entomology, as *Tenebriodes mauritanicus* (L.) was found to defoliate the tree in some regions in Cuba. The same insect, however, also was found on *Acacia farnesiana*.

A large number of species of fungi were collected on dead and dying marabu but, with the exception of the two described, all are saprophytic.

DANGER OF INTRODUCTION INTO THE UNITED STATES

The danger of introduction of the tree into the United States is very great. There seems to be little doubt that it would find suitable conditions in the southern and southwestern parts of the country. Bailey (1) has reported its introduction into southern California. Reed (3) is of the opinion that the shrub would work great damage to the cattle ranges in California if once introduced. It would be worth while to investigate rumors that the plant has been introduced into Florida.

SUMMARY

1. *Dichrostachys nutans* (Pers.) Benth., or marabu, a dangerous weed tree, was introduced into Cuba from Senegal, and has become a serious menace on the arable lands. It forms veritable forests on abandoned cane land where there are optimum conditions for its growth.

2. Eradication is extremely difficult because of the prolific sprouting of the lateral roots after the parent tree has been cut.

3. Individual plants are effectively killed by the application of crude petroleum, or other substances used in the eradication of barberry.

4. The only known practical method of eradication over large areas of pure stands is by slashing and burning.

5. The commercial utilization of the bark and wood of the marabu for tannin and charcoal products is a possibility worthy of consideration.

6. Two parasitic fungi, in addition to various saprophytic forms, are found associated with dead and dying trees. *Ganoderma pulverulentum* Murr. enters through wounds, causing a white, undifferentiated decay of the heartwood.

7. The primary cause of the death of the trees, however, is *Ustulina zonata* (Lev.) Sacc., a fungus with a wide host range in the tropics. The

production of white, fan-like mycelium beneath the bark of the tree is characteristic of it.

8. An exhaustive and careful study of the diseases and pests of the marabu should result in the discovery of a practical means of disposing of the tree.

9. Conditions are favorable for the growth of this pest in the United States, and the danger of introduction is great.

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BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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DESCRIPTION OF PLATES

PLATE VI

A. *Ganoderma pulverulentum* growing from scars at the base of marabu.
B. Fructifications of *Ustulina zonata* at the base of living marabu.
C. Bark removed from a living marabu tree showing the advance of the white mycelial layer of *Ustulina zonata* between the bark and the wood.

PLATE VII

Contrast of *Ustulina zonata* and *U. vulgaris* of the temperate zone.

A. Conidia of *U. vulgaris* × 400.
B. Conidia of *U. zonata* × 400.
C. Ascospores of *U. vulgaris* × 400.
D. Ascospores of *U. zonata* × 400.
E. Perithecia of *U. zonata* enlarged (rule in 16ths of an inch).
F. Openings of same surface of fructification, enlarged (rule in 16ths of an inch).

PLATE VIII

Ustulina zonata on marabu.

A. On small lateral root.
B. At the base of a small tree.
C. Mycelial fans in the zone of the cambium.
D. Black lines in the wood.
E. General discoloration of the wood without formation of black lines.

A
B
C

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A
B
C
D
E
F

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A
B
C
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E

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PLANT DISEASE NOTES FROM THE CENTRAL ANDES

CARLOS E. CHARDÓN AND RAFAEL A. TORO

At the invitation of the Colombian Government, the senior author spent two months—from April 16 to June 15, 1926—in the city of Medellin, organizing the agricultural department for the State of Antioquia. Since all travelling facilities were placed at his disposal, there was ample opportunity to take notes on the plant diseases of that region. The plant diseases of northern South America are very imperfectly known, owing to a lack of interest on the part of the governments in agricultural science. Thus the plant diseases of a large country as Colombia, whose area exceeds that of France and Germany combined, are wholly unknown, except for the work of the Swiss naturalists Fuhrmann and Mayor (5). The latter author, who is essentially a mycologist, gives a fairly complete account of the rust flora, and incidentally presents a fair discussion of various coffee diseases. Aside from this work, nothing is known in that remote country about plant diseases. As an illustration of this ignorance, it may be stated that as late as 1910 a serious outbreak of the Stilbum leaf spot in Cundinamarca was mistaken for the coffee rust, and great alarm was caused. Fortunately, at that time the Swiss expeditioners reached Bogotá, and Dr. Mayor promptly decided that there was nothing serious. Thus it has been deemed advisable for the present authors to write a few notes on the diseases observed.

The portion of the country visited is only a small area of the national territory. Properly speaking, it is a portion of the Central Andes. The great Andean Cordillera, as it progresses northward toward the Isthmus of Panama, becomes subdivided into three ranges: the Western Andes which are limited by the Pacific Ocean and the Cauca River; the Central Andes, which are limited by the Cauca and Magdalena Rivers, including the lovely Medellin valley; and the Eastern Andes, which run east of the Magdalena River, cover the fertile Bogotá plateau, extend to Venezuela and terminate in the snowy peaks of Sierra Nevada, in the Santa Marta peninsula. The Bogotá plateau, where the capital is located, is an extensive and rich plain, 8,000 feet above sea level. Wheat, oats, all kinds of temperate grains and fruits thrive well there. This area was not covered by the senior author, who restricted himself to the State of Antioquia, or more definitely, to the Medellin valley, including the Central Andes to the Cauca valley. (See Fig. 1.)

The valley of Medellin is 25 miles long and 4 to 5 miles wide. It is 4,500 to 4,800 feet above sea level and has a climate of perpetual spring. Medel-

lin, the capital of the State of Antioquia, is a very progressive town of over 80,000 inhabitants. It is a great coffee center, the home of the well known "Medellin Excelso" coffee, which commands the highest price in the New York market. The soil of the Medellin valley is generally poor: it has become exhausted through continuous use. Cane, corn, and beans (frisoles) are grown and there is good pasture land. South of the valley, from the town of Caldas, the country becomes rugged, and mountains ranging from 5,000 to 7,000 feet cover the territory as far as the Cauca River. These mountains are mainly of volcanic origin, the soil decomposing into a porous, gravelly loam rich in organic matter. The mean temperature ranges from 59° F. at 6,000 to 6,500 feet to 64.5° F. at 5,500 to 6,000 feet. Conditions for coffee growing are ideal here; yields are high and the berry is of extra quality. Curiously enough, sugar-cane is always grown in all the big coffee "haciendas," being cultivated in the lower lands of the plantations. Sugar is manufactured by primitive methods and a very crude brown sugar (panela) is produced. Corn and beans are universally cultivated and constitute two very important articles of food. A few temperate fruits are cultivated in the backyards of many country residences, but the apples and pears examined were quite small; peaches (duraznos) seemed to be the best adapted of the temperate fruits. The delicious "cherimoya" (*Anona cherimoya*), the queen of the tropical fruits, reigns supreme in the higher lands.

The following plant diseases were found to be prevalent by the senior author, during his relatively short visit:

Sugar-Cane "Gomosis."

A general infection of gomosis was encountered in many fields of sugar cane. The leaf symptoms were invariably those described by Matz (7) from Porto Rico and frequently observed by the senior author in the infected cane fields of that island. Longitudinal streaks of dead tissue were found beginning near the leaf tip and extending well into the leaf, running parallel to the rib. The gummy exudation of the stalk, when cut, however, was not so characteristic. Very few diseased stalks examined showed the yellow gum oozing from the fibrovascular bundles in the cut surface. This was apparently due to the very prolonged drought that prevailed in Antioquia during March, April and May. Similar cases of infected canes showing no exudation after a long, dry spell are of frequent occurrence in Porto Rico.

Microscopic examination of the diseased stalks showed the vessels plugged with the yellow gum. Disintegration of the wall of the vessels was also observed, as in typical cases of cane gomosis.

The cane variety most universally planted in Antioquia is a clean-looking yellowish cane with long internodes. It is known as "Castilla" cane,

and is claimed to have been introduced many years ago, when it completely replaced the old, degenerate "Criolla." The senior author believes this Castilla variety is the same as the "Bourbon" or "Otaheite" cane of the West Indies. In Antioquia, the Castilla variety has been grown for many years on poor soils so that it shows signs of degeneration yields, 8 to 10 tons

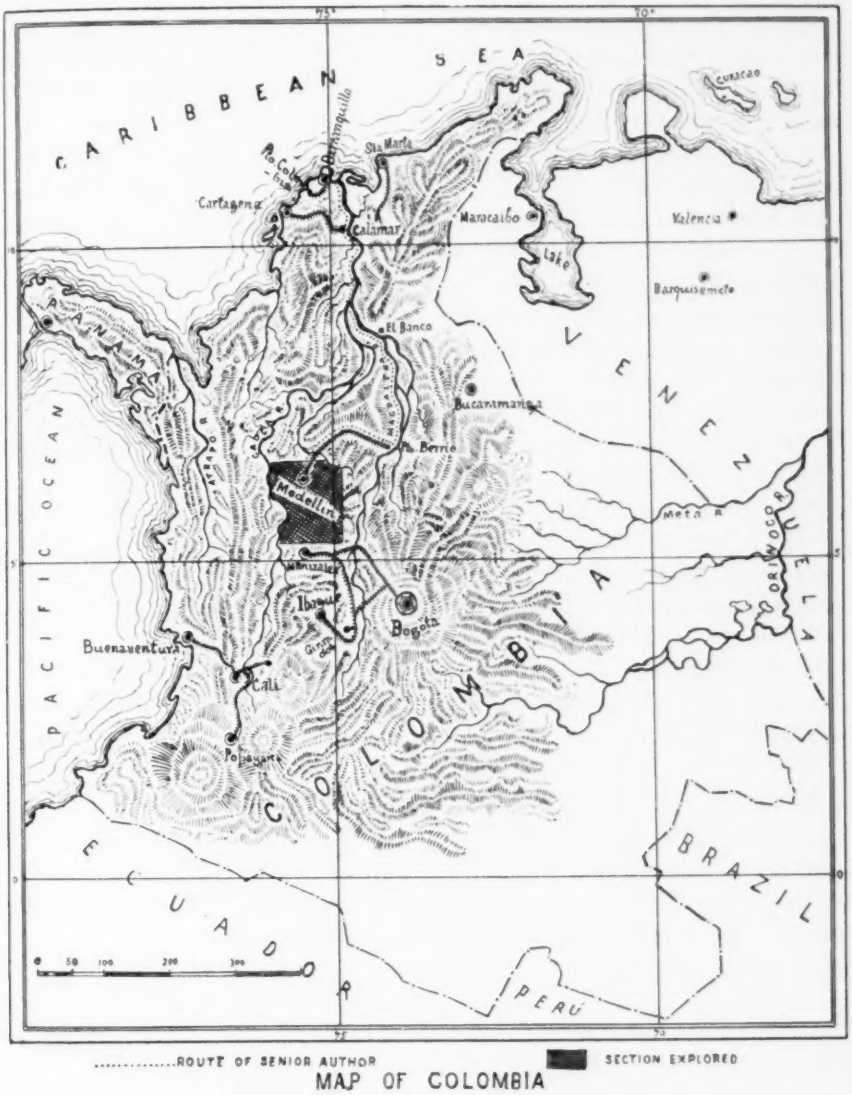

FIG. 1. Map of Colombia showing the route of the senior author and the area surveyed. Scale in kilometers.

being the average. Some "Cavangerie" and "Cristalina" canes are also grown in limited quantities. It is probably safe to assume that 90 per cent is Bourbon or Otaheite cane.

Since this appears to be the variety most susceptible to gomosis, the seriousness of the situation is very apparent. Many fields were completely infected, diseased seed was used everywhere, and there were great losses in the mills. The manager of ingenio "Santana" reported "great difficulties in the vacuum pans due to an unknown cause." The disease is so destructive that a popular circular on gomosis was issued and promptly distributed among all farmers (1).

It was impossible to trace when and how the cane gomosis found its way to the Central Andes. The disease is not known in Cuba or Santo Domingo; but in Porto Rico it was first reported by Matz (6) in 1921. No exchange of seed is known to have occurred between the latter island and any of the Colombian ports. Furthermore, the disease has been established in the Central Andes for many years, probably prior to its appearance in Porto Rico. The disease was probably introduced from Brazil, where cane gomosis had been reported by Dränert (2) as a serious malady as early as 1869.

A complete displacement of the susceptible Otaheite cane with more tolerant and higher sucrose yielding varieties is most imperative. The B.H.10(12), which is being so widely used in the British West Indies and in Porto Rico, is a cane very resistant to gomosis. This excellent variety, together with the S.C.12/4 and some of the early maturing P. O. J. canes, ought to be given a trial, and their importation to Antioquia has been strongly recommended to the Government.

Coffee Root Disease.

The etiology of the root diseases of coffee is still obscure. There are two apparently distinct coffee root troubles in America. One, reported by d'Herelle (3) from Guatemala in 1909, is known as "amarillamiento" (yellowing). He claims that it is caused by a new Pyrenomycete, which he names *Phthora vastatrix*. The fungus occurs as black bodies underneath the bark, near the base of the trunk. These black bodies are the stromata which enclose a single row of tightly pressed perithecia. The name "amarillamiento" has been applied because of the yellowing of the leaves of the diseased trees, which later dry and fall to the ground about the time of the tree's death.

Mayor (8) reported the amarillamiento as occurring in the State of Cundinamarca, Colombia, in 1912. He visited the coffee plantations of the Viola district, examined and collected plenty of diseased material, which he sent to Paris for comparison, and the disease was diagnosed as the amarillamiento of d'Herelle.

The other coffee root disease is the Rosellinia root disease of the West Indies. This malady is thoroughly described by Fawcett (4) from Porto Rico in 1915. It is said to be caused by the fungus *Rosellinia bunodes*; but perithecia were reported in two cases only, one of them being on a species of *Piper*. Specimens of the perithecial stage of the fungus have not been found at the Mayaguez Experiment Station. Thus the question of the perfect stage of the *Rosellinia* causing root disease of coffee in Porto Rico is not entirely proved. The conidial stage of the fungus (*Dematophora* sp.), however, is very common.

On the author's arrival at Medellin, repeated questions were asked him as to the presence there of a coffee root disease which was called the "llaga." It was reported to kill coffee trees in the Fredonia district. Repeated attempts to find the disease failed: many coffee trees were found dead, but their death was attributable to either white grubs or trunk borers. Finally the so-called llaga was found at the "Amparo" coffee plantation. The disease was not common, probably owing to the prolonged dry season, but the few trees examined showed unmistakable symptoms of root disease.

A few dried leaves were found on the branches of the trees which showed that their death had been recent. No external symptoms on the trunk above the surface of the soil were observed, but large black areas were seen on the roots just below the solid surface. These black areas were the llaga (canker). The cortex of the diseased root had already gone, exposing portions of the wood. The exposed wood was all black, and a hand-lens examination showed the presence of very minute fungous threads. Under the microscope they look like the *Dematophora* reported and pictured by Fawcett (4) as occurring on coffee root disease in Porto Rico. No Rosellinia stage was found. Careful search for *Phthora vastatrix* d'Herelle was also unsuccessful.

Careful comparison of the symptoms of the llaga found in Antioquia with those described by d'Herelle from Guatemala and Fawcett from Porto Rico show both diseases to have similar external symptoms. A careful investigation on the etiology of these coffee root troubles, however, needs to be made before definite relations are to be established between the root diseases found in various countries.

Coffee Leaf Spot.

The widely known leaf spot, caused by *Omphalia flavida* Maubl. et Rang., was not found on account of the drought, but it was stated to be common in shady and well protected places during the rainy season. It is known as "gotera." The disease has never been reported severe in the State of Antioquia. Years ago, it was very severe in the State of Cudinamarca, where it was mistaken for the coffee rust disease. So far, coffee rust is unknown to America.

Sooty Mold of Coffee.

Very severe cases of sooty mold were examined. The fungus (*Capnodium brasilense* Pat. and Maubl.) completely covers the surface of the leaves, the branches and even the berries. There is little doubt that the fungus injures the coffee trees by interfering with production. The sooty mold was found to be associated with an abundant cottony scale. However, the sooty mold is in itself more unsightly than harmful and is important chiefly in indicating the presence of the scale insects with which it is associated. The fungus is dependent on the honey dew secreted by these insects and disappears when they are destroyed.

Tobacco Mosaic.

Mosaic is quite prevalent on tobacco, and a high percentage of infection is often found in the fields. No one seems to care about it, nor even notice it, but the leaves showed evident damage and distortion.

Mosaic of Grasses (Cane, Corn, etc.).

Diligent search for mosaic was made on practically all the sugar plantations, but the senior author failed to find the mosaic on sugar-cane. The disease has not found its way up the Magdalena River yet. Corn did not seem to be infected either. The corn plantings were in good condition, and the corn aphis (*Aphis maidis*) was not found. The whole State of Antioquia may be safeguarded against this dangerous disease through the strict observance of proper quarantine regulations.

Bean Rust (Uromyces appendiculatus).

Rust is quite prevalent on the common bean, lima beans and the native "frisoles," but the damage observed was not important.

Fig Rust (Kuehneola fici).

Various fig trees with severe infections of rust were examined. The leaves were distorted and yellowish, showing evident damage from the rust.

Rind Disease of Sugar-Cane.

Although the rind disease of sugar cane, caused by the fungus *Melanconium sacchari* Massee, is considered by some as a serious parasite, most workers are now agreed that it is but a wound parasite and only attacks weakened or over-matured canes. The prevalence of this fungus in Antioquia can be easily explained, as has already been said, by the deteriorated varieties and very poor soil.

Ring Spot of Sugar-Cane.

Ring spot is a leaf disease of sugar-cane caused by the fungus *Leptosphaeria sacchari* van Breda de Haan. Two other species of *Leptosphaeria* on cane have been described from South America by *Spegazzini* (9). One of them is also called *L. sacchari* Speg. It does not appear to be very severe although it causes considerable discoloration of the leaf, especially at the tips.

Citrus Scab.

Scab was observed on some branches and leaves of the sour orange, *Citrus aurantium*. Some cases of distortion of leaves were seen and also falling of distorted leaves. The causal organism is a fungus recently described as *Sphaceloma fawcetti* Jenkins.

Other minor diseases.

Coconut leaves were found attacked by the fungus *Pestalozzia palmanum* Cooke; tomato leaves were heavily infected by the fungus *Septoria lycopersici* Speg; and *Phyllachora gratissima* causes a tan spot on avocado leaves.

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THE NATURE OF SEED-PIECE TRANSMISSION OF POTATO BLACKLEG[1]

J. G. Leach

Since the early investigations of Appel (1) on potato blackleg, it has been generally assumed that infected seed-pieces constitute the chief means of dissemination and hibernation of the blackleg pathogene. In fact, many investigators considered this to be the sole source of infection (6, 7). Although the statement is frequently made that "the organism . . . is carried over the seed tuber" (2), or that "infection results from the planting of diseased seed or possibly seed that has come in contact with diseased seed" (4), very little has been said about the histological details of such infected tubers. Morse (5), in 1909, states "the evidence thus far obtained indicates that blackleg is largely distributed by means of germs carried in wounds, cracks, and decayed areas of seed pieces." In 1917 (6) he again states his views as follows: "It is the writer's opinion that they are carried over winter

Fig. 1. A potato tuber taken from a plant affected with blackleg showing typical stem-end infection.

[1] Published with the approval of the Director as Paper No. 665, of the Journal Series of the Minnesota Agricultural Experiment Station.

FIG. 2. A potato tuber similar to the one shown in figure 1, cut longitudinally through the point of attachment of the stolon, showing how the discolored area tends to follow the vascular bundles.

in decaying, cracked, or otherwise imperfect tubers. . . . therefore it seems probable, if the bacteria are able to enter the interior tissues of the tuber either by natural infection in the field before harvesting, or through lesions produced by other parasitic organisms that, so long as they are supplied with a small amount of moisture, they will remain alive. The low temperatures of storage prevent their rapid multiplication and the resultant decay of the tubers. It is undoubtedly those only slightly affected tubers which are responsible for the propagation of the disease."

Orton (8) considered that contamination of the freshly cut surface of seed-pieces with bacteria from the cutting knives was sufficient to produce infection of the resulting plants and recommended disinfection of the cutting knives as a precaution. Other workers have expressed similar conceptions of seed-piece infection.

The writer (3) recently reported experiments in which a large number of seed-pieces, partly decayed with the blackleg pathogene, were planted under various soil conditions without producing the disease. The efficiency with which the seed-piece corked off the decay was pointed out and it was concluded that "the results indicate that the contamination of the seed-piece at the time of cutting usually is not an important factor in the dissemination of the pathogene."

Although there is a great deal of observational evidence that seed tubers taken from fields having a high percentage of blackleg tend to produce more blackleg than seed from disease-free fields, a survey of the literature reveals

no experiments in which tubers from diseased plants had been selected, planted, and observed in order to determine the frequency of the occurrence of diseased plants as compared with the progeny of tubers from healthy plants.

In the late summer of 1924, a quantity of tubers were selected from plants affected with blackleg. Only those tubers were saved which showed more or less decay at the stem end, which had spread into the tuber from the decayed stolon (Figs. 1, 2, and 3). The following January, 100 of these tubers were cut in half longitudinally and planted in 8-inch pots in the greenhouse. An equal number of tubers from healthy plants were inoculated with the blackleg pathogene according to the method previously described (3). When the decay was well advanced, the tubers were cut in half, planted in 8-inch pots, and placed on the bench beside the other pots in a cool corner of the greenhouse. The pots were kept well watered until maturity. On account of the low temperature, the tubers sprouted slowly and two of the artificially inoculated tubers completely decayed before forming a sprout. As the season advanced, the average temperature of the green-

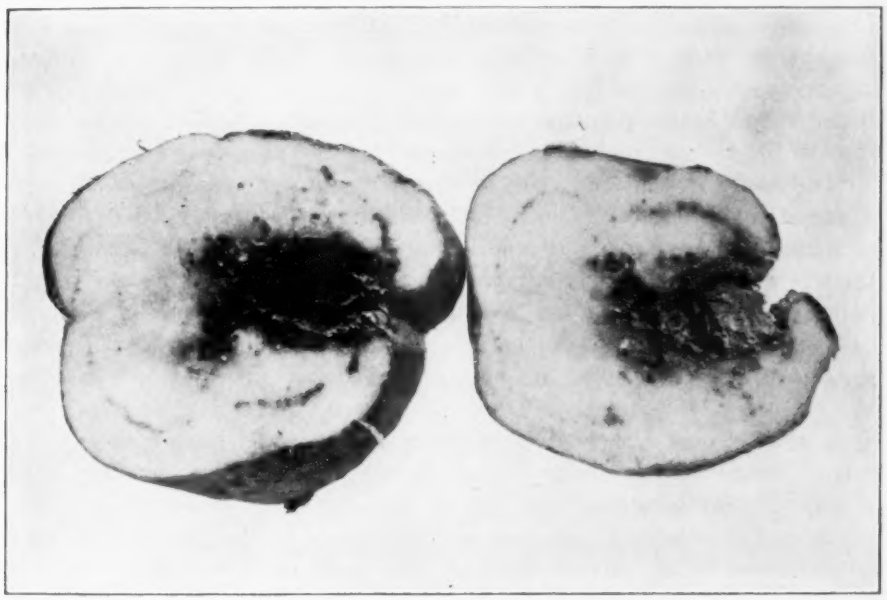

FIG. 3. A potato tuber showing a more severe case of stem-end infection. Although a considerable amount of parenchyma had decayed before the tuber was dug, when the tuber was examined in January a thick layer of cork had formed which apparently had checked the decay. However, the vascular bundles were destroyed for some distance beyond the wall of cork and, when planted, each half of the tuber produced a blackleg plant.

house rose and the plants grew at a normal rate. Twenty-four plants from the naturally infected tubers developed unmistakable blackleg, while only one plant of the artificially inoculated series developed the disease. The disease did not manifest itself until the plants were well advanced toward maturity. Tuber formation was well under way.

In 1925, another lot of naturally infected tubers were collected. These were kept in cold storage until the following spring when they were planted in the field. An equal number of artificially inoculated tubers were planted in adjacent rows. In this experiment, nine per cent of the naturally infected tubers produced blackleg plants, whereas none of those artificially inoculated produced diseased plants. Here also the disease did not appear until the plants were well advanced.

Seed-pieces, dug up when the first symptoms of the disease appeared, nearly always were found to have been affected with a watery, translucent decay. The slimy decay frequently associated with the seed-pieces of diseased plants was rarely found. In many cases the seed-pieces retained their original shape and structure, the covering of cork appearing to be intact.

The results of these experiments would seem to indicate that the natural inoculation of tubers through stem-end infection from diseased plants is much more effective than artificial inoculation. With the view of finding an explanation for this fact, a histological study was made of naturally infected tubers before planting and during the early stages of the development of the disease.

The results of this study may be summarized briefly as follows: When a stem-end infected tuber is cut in half longitudinally through the point of attachment of the stolon, it readily may be seen that the decay extends farthest along the vascular bundles (Figs. 2 and 3). The presence of the pathogene in such lesions has been demonstrated by isolations in which it has been obtained in a fair percentage of trials. Whenever any considerable amount of the parenchyma has been destroyed, careful examination shows that the decay has been checked and cut off from the rest of the parenchyma by a layer of cork (Fig. 3). It appears that it would have been entirely cut off except for its ability to invade the vascular bundles. The cells of the vascular bundles, being unable to form cork, could not stop the advance of the bacteria. As soon as the bacteria advance beyond the cork layer, formed by the parenchyma cells, they again break out of the vascular elements into the surrounding parenchyma but are soon checked by a layer of cork which quickly forms around the vascular bundle. Figure 4 shows a photomicrograph of a longitudinal section of an infected vascular bundle around which has been laid down a thick wall of cork cells. Thus the bacteria slowly advance down the vascular elements where they obtain sufficient moisture to remain alive, but from which they are unable to escape

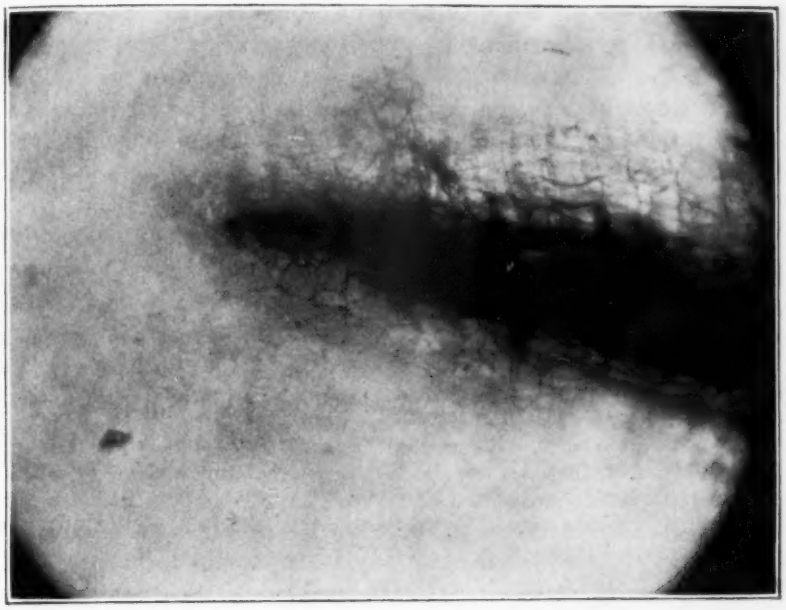

FIG. 4. A photograph of a section through a vascular bundle from a stem-end infected tuber, such as the one shown in figure 2. The elements of the vascular bundles have been destroyed, but the spread of the bacteria was checked by the parenchyma, which formed a cylinder of cork cells around the old bundle. As soon as the starch has been removed from the seed-piece by the sprout, the parenchyma is no longer able to form cork and the bacteria spread unhindered throughout the seed-piece and into the growing sprout.

on account of the effective cork wall laid down by the parenchyma cells surrounding the bundles.

When such tubers are planted, the bacteria are unable to escape from the vascular bundles until the starch has been removed by the sprout. When this stage is reached, the seed-piece is no longer able to form cork, so the bacteria develop rapidly throughout the seed-piece and spread into the stem producing the disease.

In order to prove the validity of the assumption that the seed-piece is unable to cork off the decay after the starch has been removed, a number of sound seed-pieces were removed from growing plants and inoculated with the blackleg pathogene. Normal tubers were inoculated at the same time, and all were placed over water in a closed chamber through which a stream of air saturated with moisture was drawn by means of a suction pump. The seed-pieces from which the starch had been removed were completely decayed within three days while the inoculated normal tubers remained sound and completely corked off the decay.

This study leads to the conclusion that blackleg may be systemic in nature and may be perpetuated by tubers naturally infected through the vascular bundles which enter the tuber from decaying stolons. Artificial inoculation through the parenchyma tissues appears to be relatively ineffective in producing the disease unless aided by some agency which inhibits cork formation.

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UNIFORMITY OF NOMENCLATURE FOR THE VIROSES OF SOLANUM TUBEROSUM

DONALD FOLSOM

Variation and overlapping of the symptoms of bacterial and fungous diseases, with the existing differences in national languages, render descriptive or so-called common names unsuitable as universal or standard names of such diseases. However, with respect to these diseases we can cite the pathogene for purposes of universal terminology, so that the standardization of terms can be approximated in spite of difficulties that have been encountered in the proving of pathogenicity and in bacteriological and mycological nomenclature (7, 8, 15, 16).

Certain aggregates of symptoms in potatoes (*Solanum tuberosum*) are considered to be due to corresponding degeneration diseases or viroses.[1] The existing evidence shows that one virosis may have different aggregates of symptoms as the result of differences in (*1*) the variety of potato, (*2*) the stage of growth of the potato plant, (*3*) the recency of infection, (*4*) the prevailing environmental factors, and (*5*) the number and kinds of other viroses affecting the plant (13, 14). Not only does the same virosis have different symptom aggregates, but, with a close relationship between some causal agencies apparently existing, the same symptom aggregate sometimes is ascribable to several viroses. That is, there is an overlapping of symptoms (12). This situation is like that with respect to bacterial and fungous diseases. However, there is no relief through referring to a pathogene. Of the viroses, the "aetiology will continue to be a subject of discussion until successful and convincing inoculation experiments with pure cultures of . . . possible organisms have established their relation to any of these diseases" (11, p. 24); or, it may be added for the benefit of those inclining to some other theory of causation, until the causal agency, of whatever type it may be, is isolated, identified, and proved to be the causal agency.

In the absence of knowledge of a causal agency that can serve as a tolerable universal name at least among scientists, it has been advocated that attempts be made to standardize the descriptive names of potato viroses. In standardizing in this way, the selected name will have a double use—as a more or less local descriptive name and also as a universal standard name that may not be descriptive in many localities. Such an attempted distinction may not be practicable, and at least will be confusing.

[1] A name for "virus diseases" proposed on December 28, 1925, at Lincoln, Nebraska, by Dr. L. R. Jones.

It has been maintained also, on the other hand, that it is futile to try to standardize the names of viroses in any way until the causal agencies have been determined. The inference to be drawn from this is that the determination of the causal agencies will greatly facilitate standardization. However, if we are to believe some authorities, such determination will only be the beginning of our real troubles, at least if the priority principle is followed (7, 8, 15, 16). At any rate, an indefinite postponement of a solution by deciding to wait until the causal agencies are discovered will not prove satisfactory to those workers desiring standard terms to be available soon.

There are two worthy motives for such standardization in potato viroses: the scientific and the practical. The scientific motive is a desire to attain to a more satisfactory analysis of the objective problem. The practical motive is a desire to expedite control of the diseases through certification, agricultural extension instruction, and other means that require a knowledge of names.

Among phanerogamic taxonomists the tendency seems to be toward standardization through the agreement of an authoritative, representative committee upon a definite list of standard names, following the lead of a group of practical men (1). "If these names are to be adopted by all practical and professional horticulturists, florists, nurserymen, and pharmacists, as is indicated by the endorsement of their national organizations, the professional taxonomists will find little use [on the part of the practical men] for any new or old names which they attempt to substitute or reinstate for those in this list" (15).

It is possible that students of a group of diseases can, or should, make further progress toward the standardization of terms than the students of mycology or of botanical taxonomy as a whole (3).

The preceding three paragraphs may suggest some leading of action by practical men with regard to potato viroses. However, it is quite possible for each state to have its own certification requirements, terms, and interpretation of terms and thus to bring about a local standardization that is satisfactory. That is, in practice it results in the best seed producible in that region. Also, seed growers can detect and eliminate virotic plants (those affected with viroses) without having been instructed as to the names of the viroses present. At any rate, there is no immediate prospect of the formation of a practical committee which will decide what synonyms deserve exclusive use in trade, as has been done with respect to the horticultural plants (1). Possibly the practical men realize the practical difficulties more keenly than do some who advocate immediate standardization.

Some scientific workers think it possible both to attain to a more satisfactory analysis of the objective problem and to advance standardization of terms through a comparison of published descriptions. For example, after

the statement that "mosaic itself is now believed to comprise several distinct forms of disease," the symptoms of mosaic are given as mottling and crinkling; and subsequently there is given: "Crinkle.—This disease appears to be the same as the rugose mosaic of Schultz and Folsom in the United States of America." (2, p. 45, 48, 51.) Also, "Streak.—There is probably more than one form of streak. The form described by Orton and later by Atanasoff has been called by the latter stipple streak." (2, p. 51.)

Atanasoff, discussing the question of uniformity of names, is more pessimistic. He states that:

"Words like 'dwarfing,' 'wrinkling,' . . . 'curly-dwarf' . . . etc., . . . are meaningless because they are too broad and too general and because they are not sufficient in themselves to describe a whole complex of symptoms. What is still worse is that one author calls a certain disease 'leaf roll,' another author speaks of the same disease as 'leaf curl'; one uses the name 'streak,' the other the name 'stipple-streak' for the same disease; one speaks of 'crinkle,' the other of 'rugose mosaic' and they both mean the same disease. . . . The only result of this deplorable practice is that even the men working on this problem cannot understand each other's writings, let alone those who are not familiar with these diseases." (4, p. 521–522.)

The preceding suggests the question, is it consistent to state that names are meaningless when two such names are said to belong to the same disease? Also, is it consistent to apply a new name to what is believed to be the same disease and then to deplore the bad example thus set? There may rather be a need for a retention of names already in use, when possible; for definitions of terms applied to unit symptoms (14, p. 44–45); and for a desire to understand such terms rather than to try to become famous through initiating new ones. However, there is a difficulty still more fundamental than those which have been referred to. Even with all workers on potato viroses cooperating as much as is possible through the literature and correspondence, a general agreement as to the facts will come about only with a liberal exchange of carefully grown tubers perpetuating different diseases. Even with that practice established, there will have to be liberality in regard to uncontrollable mistakes following transmission by as yet unknown agencies, and comparisons should be made as far as possible in controlled environments (5, 6, 9, 10, 17).

Some of the quotations given in previous paragraphs indicate incidentally the best present method of designating a potato virosis, that is, to name the virosis, the author of the original description, and if possible the date and place of publication. After the materials upon which such descriptions are based have been exchanged and studied in a truly cooperative spirit, eventually it may be possible to assemble a committee with authority and knowledge enough to select synonyms which will be regarded as standard. Such

a committee probably will have to include one or more representatives of the chief phytopathological society of each nation, or, if there is no such society, then the chief botanical society, with at least a four-fifths majority required to list a name as approved or as synonymous with an approved name.

Perhaps there is need for such a committee to consider viroses of all plants instead of potato viroses alone. In such a case each species of plant should have a list of viroses authorized, and the identity of viroses of different plants should be shown in a suitable manner. Possibly it would be simpler, and as satisfactory on the whole, to designate the different viroses of a species by Arabic numerals. We might thus have designated, for example,—"*Solanum tuberosum* L., virosis 1. Described as *rugose mosaic* by E. S. Schultz and Donald Folsom in Jour. Agr. Res. **25**: 52–53, 61. 1923. Synonym *crinkle* as described by Paul A. Murphy in Canada Exp. Farms Div. Bot. Bul. 44, II. 71–74. 1921. Identical with *Nicotiana tabacum* L., virosis 5, and with *Lycopersicon esculentum* Mill. virosis 2." If, in spite of many data and due deliberation, the committee should allot a number to a combination of viroses, when the mistake becomes evident it would be easy to state that the so-called virosis is a combination of certain new ones. A numerical designation as a standard would be simple, would be indefinitely expansive, would be impartial to the different theories of causation and relationship of viroses, and would be usable by all writers employing Latin binomials of the host plants. It could, in fact, be used without the names of the host species in a single series of numbers.

It would be a desirable step for an authoritative committee at least to agree upon what is required in the way of proof that a virosis has been sufficiently studied to deserve a standard name.

SUMMARY

Reasons and methods have been advanced for the standardization of names of potato viroses. The writer suggests an authorized scientific committee for the selection of satisfactory descriptions and their standard designation by number in a separate series for each species of host plant, or in a single series.

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A STUDY OF THE DISTRIBUTION OF TILLETIA TRITICI AND T. LAEVIS IN 1926[1]

W. H. Tisdale, C. E. Leighty, and E. G. Boerner

During the past few years the losses in the United States due to stinking smut of wheat have been increasing very noticeably. Estimated reductions in yield during the years 1917 to 1924 indicate that the losses run from 5,000,000 to 26,000,000 bushels a year. The average estimated reduction in yield during this period was over 14,000,000 bushels annually. The greatest loss occurred in 1924, when over 26,000,000 bushels were destroyed by stinking smut. This wide range in the amount of reduction in yield, with the heaviest loss occurring in 1924, may be attributed to the fact that an intensive campaign for smut control was conducted by the United States Department of Agriculture in 1918 and 1919. This resulted in a greatly increased use of seed treatment which, no doubt, was responsible to a large extent for the low percentages of smut in the earlier years of this period. After this campaign had become forgotten there was a decrease in the amount of seed treatment due probably to a large extent to the rapid decline in the price of wheat about 1920, which caused the farmers to lose much of their interest in the crop. The result was a gradual increase in the percentage of smut infection which culminated in the enormous loss in 1924. In addition to this reduction in yield there is a very heavy loss due to price discounts on smutted wheat at the market. These discounts range from a few cents to 25 cents per bushel.

The prevalence of smut in 1924 is largely responsible for the subsequent heavy losses in 1925 and 1926 in the Middle West and the Eastern States. This was due to the use of smut-infested seed wheat in those years. In the regions named, soil infestation is not an important factor and the smut is spread principally with the seed. In the Pacific Coast States, where soil infestation is an important factor, epidemics of smut cause a heavier infestation of both seed and soil.

There has been considerable speculation regarding the cause or causes of this increase in stinking smut, especially east of the Rocky Mountains. Weather conditions following sowing of wheat are known to influence infection. Temperatures ranging between 5° and 15° C. are highly favorable

[1] Investigations conducted cooperatively between the Office of Cereal Crops and Diseases, Bureau of Plant Industry, and the Grain Division of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

for infection by either species of *Tilletia*.[2] Some of the state pathologists are inclined to believe that the increase in the percentage of smut is due to the more general practice of sowing late to escape Hessian fly injury. The late sowing, of course, subjects the germinating seed to lower temperatures, which in turn favor infection. As previously stated, one of the chief causes for the increasing percentages of smut may be the decrease in seed treatment resulting from the low smut infection following the smut control campaign in 1918 and 1919. This may be one of the chief reasons for the increases of stinking smut. Of course, it is necessary that the seed carry smut spores if infection is to take place, as soil infestation is seldom known to cause infection east of the Rocky Mountains. Once the smut occurs in a locality it is easily spread through the distribution of seed and by the use of the threshing ring where the same machine is used on several farms.

Even though the later sowing of wheat seemed to favor increased smut infection, the writers developed another theory. They thought it possible that *T. tritici*, the species commonly present in the Pacific Coast region, and known to occur locally east of the Rocky Mountains, might have become widely distributed in the East and for some reason might be more virulent than *T. laevis* under eastern conditions, and thus be responsible for the smut epidemics. A report by Haskell in The Plant Disease Bulletin, June 20, 1919, on the distribution of the two species of *Tilletia*, showed the occurrence of *T. tritici*, the western species, only as far east as Indiana and Michigan. *T. laevis* occurred from coast to coast but was found to be much more prevalent east of the Rocky Mountains. In this survey, however, very few collections of smut were made in the States east of the Mississippi River. It seemed possible that *T. tritici* might have become spread throughout the East since that time. There also is the possibility of strains of different virulence, in either one or both of these species, which might account for the increasing prevalence of the disease. With these points in mind, 900 addressed seed envelopes were sent to nine grain terminals east of the Rocky Mountains, 100 to each terminal, with a request for samples of smutted wheat from receipts from various localities within their respective territories. About 560 samples were received, each representing a carload shipment from a country point, and the species of *Tilletia* present were determined. Tables 1 and 2 and the accompanying map give the distribution of the two species of *Tilletia* as shown by these samples.

A study of the tables and the map (Fig. 1) do not indicate that *T. tritici*, the western species, is at all responsible for the epidemics of stinking smut east of the Rocky Mountains.

[2] Faris, J. A. Factors influencing the infection of wheat by *Tilletia tritici* and *Tilletia laevis*. Mycologia 16: 259–282. 1924.

TABLE 1.—*Geographic distribution of Tilletia tritici and T. laevis in the four states, Minnesota, Montana, North Dakota and South Dakota, where both were found, as indicated by their occurrence in samples of smutted wheat originating at the points named, in 1926*

Where grown		Terminal	No. of samples	Species of *Tilletia*
State	Locality			
Minnesota	Barnesville	Duluth, Minn.	1	*tritici*
	Dumont		1	do
	Kenyon		1	do
	Tenney		1	*laevis*
	Billings	Minneapolis, Minn.	1	do
	Brushvale		2	do
	Buffington		1	*tritici*
	Hallock		1	*laevis*
	Lafayette		1	do
	Maplelake		1	do
	Seaforth		1	do
Montana	Benchland	Duluth, Minn.	1	do
	Brampton		1	*tritici*
	Bush Siding		2	*laevis*
	Charlo		1	do
	Hysham		1	do
	Laurel		1	do
	Libby		1	do
	Springfield		1	do
	Big Sandy	Minneapolis, Minn.	1	do
	Columbus		1	do
	Denton		1	do
	Glentana		1	do
	Hobson		1	do
	Mocassin		1	do
	Poplar		1	do
	Underdahl		2	do
North Dakota	Absaraka	Duluth, Minn.	1	*laevis* and *tritici*
	Adams		1	*tritici*
	Ahame		1	*laevis* and *tritici*
	Alice		1	*tritici*
	Bremen		1	do
	Buffalo		1	do
	Casselton		1	do
	Casselton		1	*laevis*
	Cheyenne		1	*tritici*
	Churchs Ferry		1	do
	Clementsville		2	do
	Amherst		1	do
	Buttzville		1	do
	Thompson		1	do

TABLE 1.—*Continued*

Where grown		Terminal	No. of samples	Species of *Tilletia*
State	Locality			
North Dakota	Dahlen	Duluth, Minn.	1	*tritici*
	Dalrymple		1	do
	Delamere		1	*laevis* and *tritici*
	Egeland		1	*tritici*
	Elizabeth		1	*laevis*
	Enderlin		2	*tritici*
	Erie		1	do
	Florence		1	do
	Frazier		1	do
	Glasston		1	do
	Golden Valley		1	do
	Grandin		1	*laevis*
	Hannaford		1	*tritici*
	Hensol		1	*laevis*
	Jessie		2	*tritici*
	Josephin		1	do
	Lamars		1	*laevis*
	Lanona		1	do
	Lawton		1	*tritici*
	Lead		1	do
	Ledgerwood		1	do
	Maza		2	do
	Maxbass		2	do
	Minnewaukin		1	do
	Munster		1	do
	Munster		1	*laevis* and *tritici*
	Mylo		1	*tritici*
	Northwood		2	do
	Odessa		1	*laevis*
	Osnabrock		1	*tritici*
	Ottertail		1	*laevis*
	Parduloe		1	*tritici*
	Persis		1	*laevis*
	Petersburg		1	*tritici*
	Rauville		1	do
	Reeder		1	*laevis*
	Rogers		1	*tritici*
	Stirum		3	do
	St. Thomas		1	*laevis*
	Venango		1	do
	Walum		1	*tritici*
	Webster		1	do
	Wheaton		1	do
	Wishek		1	*laevis*
	Ypsilanti		1	*tritici*

The tables and map show that *T. tritici*, the western species, was found only in samples grown in Montana, North Dakota, South Dakota, and Minnesota. These samples were received from Minneapolis and Duluth. Of the 71 samples in which only *T. tritici* was found, all were durum wheat. Many of these, however, contained small admixtures of common wheat. Seven of

TABLE 1.—*Continued*

Where grown		Terminal	No. of samples	Species of *Tilletia*
State	Locality			
North Dakota	Baden	Minneapolis, Minn.	1	*laevis*
	Blanchard		1	do
	Brandt		1	*tritici*
	Clementsville		1	*laevis*
	Corinth		1	do
	Forman		1	do
	Hillsboro		2	do
	Lansford		1	do
	Marshall		1	do
	McClusky		1	do
	Mott		1	do
	Parshall		2	do
	Tunbridge		1	do
	Warwick		1	do
	Wimbledon		1	*laevis* and *tritici*
	Blackwell	Oklahoma City, Okla.	1	*tritici*
South Dakota	Bristol	Duluth, Minn.	1	do
	Deblen		1	*laevis*
	Rofhalt		1	*tritici*
	Tacoma		1	do
	Veblen		1	do
	Belvidere	Minneapolis, Minn.	1	do
	Creston		1	*laevis*
	Draper		1	*tritici*
	Faulkton		1	*laevis*
	Freeman		1	*tritici*
	Garden City		1	do
	Grover		1	do
	Hart		1	*laevis* and *tritici*
	Kampeska		1	*tritici*
	Labolt		1	*laevis*
	Langford		1	*tritici*
	Lemmon		1	*laevis*
	Oelrichs		1	do
	Peever		1	*tritici*
	Philip		1	*laevis*
	Strandburg		1	*tritici*
	Unity Ville		1	do
	Wessington Springs		1	*laevis*
	Hitchcock		1	do

these 71 samples were principally red-kerneled durum, three were mixtures of red-kerneled and amber-kerneled durums, and the remainder were principally amber-kerneled durums. The five samples from North Dakota and the single sample from South Dakota, in which both *T. laevis* and *T. tritici* were found, were mixtures of durum and common wheats, the approximate percentages of durum being 94, 80, 88, 90, 3, and 96 per cent, respectively.

In all of these samples very few smut balls were present, and only two samples contained kernels with smutted tips, and but a few of these. It is possible that *T. tritici* was produced on the common wheat in some or all of these samples, but *T. tritici* was not found in the samples of common wheat in which no durum was present.

If the samples examined can be considered as representative, they furnish strong indications that *T. tritici*, in the upper Mississippi and Missouri Valleys, is confined almost entirely, if not entirely, to durum wheat. It is not known why this should be the case, as all the common wheats grown in that region are more or less susceptible to infection by *T. tritici*, and the durum

TABLE 2.—*Summary showing the occurrence of Tilletia tritici and T. laevis in samples of wheat collected at several grain terminals in the Middle Western and Eastern States in 1926*

Regions and State or Province	No. of towns	Number of samples containing *Tilletia*		
		tritici	*laevis*	*tritici* and *laevis*
West of Mississippi River				
Northern Section				
Minnesota	11	4	8	
Montana	16	1	17	
North Dakota	58	52	28	5
South Dakota	24	14	9	1
Central and Southern Sections				
Colorado	14		17	
Kansas	60		79	
Nebraska	31		40	
Oklahoma	33		59	
Texas	6		15	
Utah	1		1	
East of Mississippi River				
Delaware	23		50	
Illinois	2		2	
Indiana	9		12	
Iowa	5		5	
Maryland	38		68	
Michigan	1		1	
Ohio	8		11	
Pennsylvania	33		46	
Virginia	2		3	
Canada				
Ontario	2		2	

wheats are likewise susceptible to infection by *T. laevis*. Both durum and common wheat are grown in the same localities, often on the same farm. They are sown with the same drills, handled with the same machinery and threshed in the same machines. Samples of common and durum wheats were received from the same general area and it is hardly likely that durum has not had opportunity for infection by *T. laevis* and the common wheats by *T. tritici*.

Another question regarding *T. tritici* is why it should remain confined to limited areas east of the Rocky Mountains, where there are so many possibilities for its spread. Perhaps there are climatic factors which limit its distribution. *T. laevis* was found throughout the entire area from which these samples were received, extending from Maryland and Delaware on the Atlantic Coast to Utah and Montana in the West.

Although it is not possible to determine strain differences within the species until further study is made, it is certain that, if a specially virulent strain is responsible for the epidemics east of the Rocky Mountains, it is a strain of *T. laevis*, the species commonly occurring in the East. In examining the samples considerable differences in the shape and appearance of

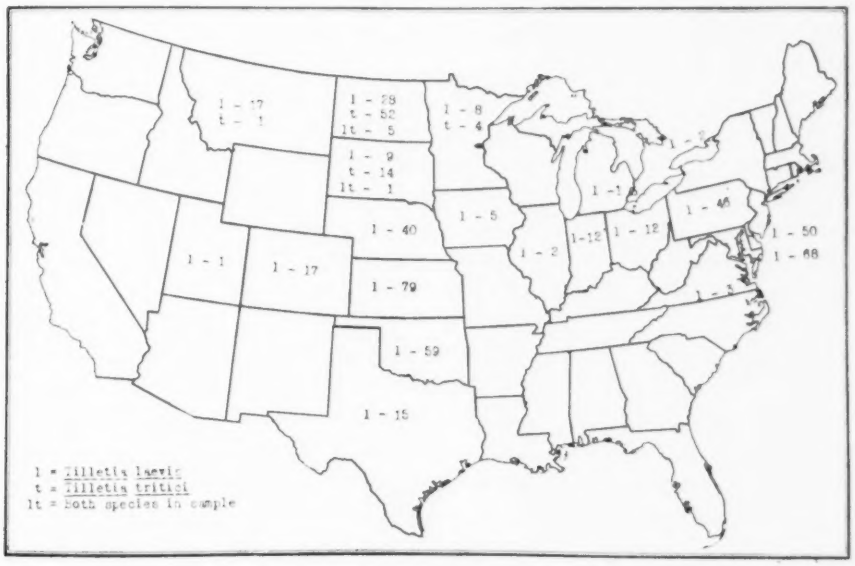

FIG. 1.—Map showing the distribution of *Tilletia tritici* and *T. laevis*, causing stinking smut of wheat, in a number of samples of wheat obtained from several marketing terminals in 1926.

spores of *T. laevis* were noted in different samples and at times in different smut balls within the same sample. The spores of *T. tritici* varied from very echinulate to almost smooth. In fact, the two species seemed to merge or overlap in this respect. This morphological variation may or may not be correlated with any physiological variations that may exist within the species.

OFFICE OF CEREAL CROPS AND DISEASES,
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UNITED STATES DEPARTMENT OF AGRICULTURE

EXPERIMENTS WITH DUSTS FOR CONTROLLING STRIPE DISEASE OF BARLEY[1]

R. W. Leukel, James G. Dickson, and A. G. Johnson

The widespread use of copper carbonate for the control of bunt during the past few years naturally suggested the use of dusts for controlling other seed-borne diseases of cereals. Howitt and Stone (7) found that copper carbonate controlled smut in Liberty Hull-less oats. Heald, Zundel and Boyle (5) reported perfect control of oat smut with copper carbonate in Chinese Hull-less oats but not in the hulled varieties Swedish Select and Abundance. Sampson and Davies (11) found that copper carbonate reduced the amount of smut in hull-less oats 70 per cent. Dickson (1) also found nickel and copper dusts satisfactory for controlling smuts in hull-less oats. Martin (9) reduced the amount of smut in oats from 4.13 per cent to 0.22 and 0.85 per cent with nickel carbonate and copper carbonate, respectively. He did not state whether hulled or hull-less oats were used. Thomas (12) found that, although copper carbonate, nickel carbonate, and copper sulphate dusts used alone were ineffective against oat smuts, a mixture of any of these with mercuric chloride controlled the oat smuts satisfactorily.

Holbert, Reddy and Koehler (6) report increased yields after dusting Diplodia- and Gibberella-infected seed of dent corn with various organic mercury compounds. Reddy, Holbert and Erwin (10) likewise reported similar results from dusting Diplodia- and Gibberella-infected seed of sweet corn with certain organic mercury compounds. The increased yields doubtless indicate at least partial control of the seed-borne diseases mentioned.

Gram (4) reported some success in controlling stripe disease of barley by dusting the seed with powdered Germisan and Tillantin "C". Dorph-Petersen (2) stated that out of 12 barley fields, seed for which had been dusted with various new preparations, eight remained free from stripe disease, while the rest showed only a trace of infection. Gisevius and Straib (3) completely controlled stripe disease of barley with the two dusts, Höchst and Tutan, using them at the rate of 4 grams per kilogram of seed. Abavit "B" reduced the amount of stripe to 1.5 per cent, while the controls showed 5.4 per cent. In preliminary experiments in 1925 with a number of

[1] Investigations conducted cooperatively between the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Wisconsin Agricultural Experiment Station.

dusts, the writers (8) obtained results in the control of stripe disease of barley which appeared to justify further work along this line. Accordingly, somewhat more extensive seed-treatment experiments with dusts for stripe-disease control were undertaken in the spring of 1926.

MATERIALS

Dusts which previously had been found ineffective (8) in controlling stripe disease were not included in these experiments. Following is a list of the dusts used in the experiments here described, together with the names of the commercial concerns manufacturing them.

1. Abavit "B."—Chemische Fabrik Ludwig Meyer, Mainz, Germany.
2. S. F. A. No. 225
3. S. F. A. No. 225V
4. S. F. A. A–Z–III

   Saccharin-Fabrik Aktien-gesellschaft vorm Fahlberg, List and Company, Magdeburg, Südost, Germany.
5. S. I.–220.—Actien-Gesellschaft für Anilin Fabrikation, Wolfen, Kreis Bitterfeld, Germany.
6. Bayer Dust.—Bayer Company, Inc., New York City.
7. Semesan
8. Semesan Jr.
9. Du Pont No. 12
10. Du Pont No. 12 Bel
11. Du Pont No. 13–U. A.
12. Du Pont No. 18
13. Du Pont No. 37
14. Du Pont No. 45
15. Karasch Compound A.
16. Karasch Compound B.
17. Karasch Compound C.
18. Karasch Compound D.
19. Karasch Compound E.

    E. I. du Pont de Nemours and Company, Wilmington, Del.
20. Mercury "C."—Roessler Hasslacher Company, Perth Amboy, N. J.
21. "Wa-Wa Dust."—Chicago Process Company, Chicago, Ill.

The seed used was Oderbrucker barley (Wisconsin Pedigree No. 6, C. I. No. 1146), grown in 1924 by the Agronomy Department of the Wisconsin Agricultural Experiment Station on the West Hill Experiment Farm, near Madison, Wis.

METHODS AND RESULTS

The seed was dusted by placing 350 grams of barley in a two-liter Erlenmeyer flask and adding an even tablespoonful of the dust to be used. After shaking the flask sufficiently to coat thoroughly every kernel with the dust, the seed was poured into a coarse sieve to remove the excess dust. The seed was then packeted and sown in triple rod rows in two parallel series (Series I and II) and each series replicated three times. Series I was sown on the Arlington Experiment Farm, Rosslyn, Va., March 30, 1926. Series II was sown on the Wisconsin Agricultural Experiment Station Farm near Madison, Wis., two of the replications being sown on April 30, and the third on May 6, 1926. In both series, untreated controls were sown for purposes of

comparison. The rainfall and soil temperature data for the periods from a few days before the seed was sown until after the seedlings had emerged are shown in table 1.

Infection data were taken on Series I, June 9–12, 1926. In each of the triplicated rod rows, the plants in the middle row were pulled and the diseased and healthy plants counted. In the remaining rows only the striped plants were pulled and counted, the total number of plants in the middle rows serving as the basis for estimating the percentages of infection. A summary of the data is given in table 2.

TABLE 1.—*Rainfall and soil temperature data for the periods March 25 to April 15, 1926, at Arlington Experiment Farm, Rosslyn, Va., and April 24 to May 15, 1926, at Madison, Wis., in connection with experiments for the control of stripe disease of barley by the use of dust seed treatments.*

Series I, at Arlington Experiment Farm					Series II, at Madison, Wisconsin				
Date	Rainfall in inches	Soil temperature in degrees C.			Date	Rainfall in inches	Soil temperature in degrees C.		
		Maximum	Minimum	Mean			Maximum	Minimum	Mean
March 25		13	3	8	April 24	1.00	6	1	4
26	.29	8	1	4	25		12	0	5
27	.21	8	−1	3	26		7	2	4
28		8	−2	2	27	.09	11	2	6
29		11	−2	4	28		12	2	7
30*		12	−2	5	29		24	6	15
31	.43	7	4	5	30		28	8	19
April 1	.07	8	0	4	May 1[a]		30	5	19
2		12	−1	5	2	.80	22	8	14
3		13	3	7	3	T	9	2	6
4	.02	12	1	6	4	.04	14	3	9
5		6	0	2	5		28	12	19
6		0	−3	−2	6[c]		29	12	20
7	.16	10	−2	5	7		30	13	22
8	.17	10	5	8	8[b]	T	25	13	19
9	.27	11	0	6	9		19	7	14
10		11	0	6	10		16	6	11
11		6	0	4	11		18	4	11
12+	.17	11	−2	5	12		20	6	13
13		8	3	5	13	.05	12	7	9
14	.02	15	4	9	14[d]	.29	12	4	7
15		13	4	8	15		23	4	14

[a] First series sown. [b] Emerged. [c] Second series sown. [d] Emerged.

T—Indicates trace of precipitation.

*—Date sown.

+—Date emerged.

DISCUSSION

The average percentage of infection in the controls in Series I was 19.47 per cent, while that in Series II was 12.77 per cent. The greater amount of infection in the former was due undoubtedly to the lower soil temperature prevailing during the period of germination, as shown in table 1.

Seven of the dusts used did not control the stripe disease sufficiently to merit further discussion. They were: S.F.A. A-Z-III, Du Pont No. 37 and Karasch Compounds "A," "B," "C," "D," and "E."

TABLE 2.—*Summary of data on the control of stripe disease in Wisconsin Pedigree No. 6 barley by the use of various proprietary chemical dusts. Seed sown in triplicated rod-rows replicated three times on Arlington Experiment Farm, Rosslyn, Va., and at Madison, Wis., in the spring of 1926*

Number	Treatment	I. Arlington Exp. Farm			II. Madison, Wis.			Average per cent stripe
		Total plants	Striped plants		Total plants	Striped plants		
			Number	Per cent		Number	Per cent	
–	Control	2043	438	21.44	Average of	271	12.04	16.74
1	Abavit "B"	2475	1	.04	250 plants	5	.22	.13
2	S.F.A. No. 225	2421	29	1.20	per row or	49	2.18	1.69
3	S.F.A. No. 225V	2212	6	.27	2,250 plants	13	.58	.43
4	S.I. 220	2178	8	.37	for each	53	2.36	1.37
5	Bayer Dust	2583	28	1.08	treatment	41	1.82	1.45
6	Semesan	2493	24	.96	and corre-	18	.80	.88
–	Control	2160	405	18.75	sponding	313	13.91	16.33
7	Du Pont No. 12	2538	5	.20	control.	1	.04	.12
8	Du Pont No. 12-Bel	2475	30	1.21		15	.67	.94
9	Du Pont No. 13-U.	2601	12	.46		14	.62	.54
10	Du Pont No. 13-U.A.	2952	13	.44		22	.98	.71
11	Du Pont No. 18	2610	31	1.19		41	1.82	1.51
12	Du Pont No. 45	2196	3	.14		10	.44	.29
	Control	2016	368	18.25		278	12.36	15.31
13	Mercury "C"	2700	4	.15		14	.62	.39
14	"Wa-Wa Dust"	2376	1	.04		0	.00	.02

"Wa-Wa Dust" almost eliminated the stripe disease, only one infected plant being found in Series I and none in Series II. Abavit "B" and Du Pont No. 12 also were very effective, each allowing a total of only six striped plants to appear in the combined series. Six of the other dusts reduced the amount of infection in both series to less than one per cent. The plant counts in Series I (table 2) indicate that the treatments also improved the stand.

As shown in table 1, sufficient rain fell shortly after Series I was sown and after sowing the first two replications of Series II almost to saturate the

soil, as at the time of sowing both at Arlington Farm, Va., and at Madison, Wis., the soil already contained considerable moisture. This abundant soil moisture during the germination period may have increased the effectiveness of the dusts and consequently may have brought about better stripe control than would have been the case if the soil had been relatively dry. Controlled soil-moisture experiments are necessary to determine whether this is the case. In addition to this, it also will be desirable to test the effectiveness of these dusts on other varieties of stripe-infected barley before they can be recommended to take the place of the liquid treatments for the control of stripe disease. The possibility of soil reaction influencing the results also should be considered.

Therefore, while the results with certain of these chemical dusts for the control of stripe disease are very promising, additional experiments are needed to determine whether similar results would be obtained with different soil conditions and with other varieties of stripe-infected barley.

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THE OCCURRENCE OF BLAKESLEA TRISPORA THAXTER IN THE DUTCH EAST INDIES

S. C. J. Jochems

Thaxter (4), in 1924, described a zygomycete of very interesting morphology which he had encountered as an impurity in a culture of *Botrytis rileyi* from Florida. He named the organism *Blakeslea trispora*.

This fungus, so far the only known species of *Blakeslea*, is very closely related to *Choanephora*. The latter is distinguished by conidiospores and sporangiospores. *Blakeslea*, on first view, is similar: its cultural characters are much like those of a *Choanephora*. On further investigation, however, it can be seen that the conidia of *Blakeslea* are in reality small sporangia, each with a small number of spores—usually four, although the number varies from three to seven. Thaxter called these sporangia sporangiola.

In addition to a detailed description, Thaxter included a few very clear drawings showing the morphology of *Blakeslea*.

Concerning the distribution of the mold, he only says:

"This interesting type, which has been named in honor of Professor A. F. Blakeslee, in recognition of his brilliant researches on the Mucorales, appeared as an impurity in a transfer of *Botrytis rileyi* which was kindly sent me several years ago, together with specimens of the affected larvae, by Professor Faweett. The larvae attacked by the *Botrytis* were found on cowpeas at Gainesville, Florida, and it seems probable that the spores of the present fungus, which may have been growing on the faded flowers of this plant, were accidentally transferred to the diseased insect."

Our phytopathological researches on Deli tobacco during the last three years have led us to believe that *Blakeslea trispora* is extremely common on the East Coast of Sumatra. Although our investigations so far have been confined to this region, we are convinced, as we shall show later, that it is distributed at least over all the Dutch East Indies.

We first encountered *Blakeslea* on faded tobacco leaves (Fig. 1) and particularly on those leaves which were infested by the great green tobacco bug (*Nezara viridis*). As a result of the infestation by *Nezara*, the leaf partly loses its turgescence and never recovers. Exactly how this takes place is not known, but we do know that some days after the leaf is infested, it becomes very weak. *Blakeslea* is then able to infect the leaf and hasten the

FIG. 1. *Blakeslea trispora* on tobacco leaf.

dying-off process. We have seen such heavy attacks of *Nezara* on tobacco estates that not only one top leaf wilted, as is usually the case, but that entire tops of many tobacco plants which were growing closely together began to fade. Parts of the wilted leaves were covered so thickly with Blakeslea fructifications that at one time we thought the mold was the primary cause of the wilting. However, we consider the *Blakeslea* as only a weak parasite, because we have never been able to obtain infections on healthy tobacco plants. The same is true of *Choanephora infundibulifera*, which is sometimes quoted as a parasite of the Hibiscus flower (2).

In addition to finding *Blakeslea* on faded leaves of the tobacco plant, we found it in drying sheds on newly plucked leaves whose tissues were still green and alive. The mold is also to be found in extraordinarily large quan-

tities, in Deli, on the plucked young flower-plumes which are broken off in the Delian tobacco culture and are to be found, sometimes in great quantities, on the ground under the plants. A few days later, particularly in the early morning, these are covered with the white bedewed fructifications.

In addition to tobacco, we found this mold on faded leaves of *Physalis angulata*, *Ipomoea batatas* and probably on some other plants. On these plants, mixed with the *Blakeslea*, there appeared another *Choanephora cucurbitarum*, which we described some time ago in an article on *Amaranthus blitum* (= *A. lividus* L.) (3). On this plant *C. cucurbitarum* is a true parasite. It causes the branches to die off, or, if the attack is very severe, kills the whole plant. On tobacco we have never been able to find it as a true parasite.

In our cultivation experiments (mostly on boiled, sterilized rice) and studies of the morphology of our fungus, we found a great deal of resemblance to *Blakeslea trispora*, described by Thaxter. The only point of difference was the number of spores per sporangiolum. Thaxter gave from three to six with a total of three in most cases, as he indicates in the specific name. We nearly always found more than three, in most cases four, although the number varied between three and seven.

Gandrup is the only one, who, according to Ultée (5), appears to have seen this fungus in the Dutch East Indies and made mention of it. An early annotation concerns a *Choanephora* variety in cultures originating from diseased tobacco bibit. The mold was noticed also in the plant-beds. The symptoms were the same as those which resulted from infection by *Phytophthora nicotianae*. Healthy bibit in pots was inoculated with this *Choanephora* species but in no case was infection obtained. According to Gandrup, the fungus was a new variety, and he named it *Choanephora dichotoma*. A further description will be given at a more convenient time.

In a second annotation, Gandrup (1) mentions among the molds obtained in pure culture from drying tobacco leaves, in addition to *Choanephora infundibulifer* (Cunn.) Sacc., a new *Choanephora dichotoma*. According to him, the *Choanephora* varieties grew only on freshly-plucked leaves which were not yet dead.

On the basis of further information from Mr. Gandrup himself concerning the morphologic qualities of the above *Choanephora dichotoma*, we are convinced that he was referring to *Blakeslea trispora*.

When one considers that *Blakeslea* appears in the entire tobacco district of East Sumatra, in a climate of equal warmth and rain throughout the year, and that it probably also can be found in a climate which is very dry during one-half of the year, as it is in the east corner of Java, it seems safe to conclude that *Blakeslea* is distributed throughout regions of intermediate

climate situated between these two. Research undoubtedly will establish the presence of this interesting fungus elsewhere in the tropics.

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APPLE BLOTCH CANKER ERADICATION[1]

MAX W. GARDNER[2]

By the omission of the blotch sprays from blocks of bearing trees in two young apple orchards of the very susceptible variety, Oldenburg (Duchess), at Vincennes, Indiana, the effectiveness of early canker eradication and prevention has been demonstrated. The methods employed and the earlier stages of the work in these orchards have been described previously.[3] Briefly, the process consisted in shaving off or pruning out the old cankers of the blotch fungus (*Phyllosticta solitaria* E. and E.) and spraying to prevent the formation of new cankers.

One of the unsprayed blocks was located in a small planting of 156 Oldenburg and 61 Transparent trees set out in 1918, and the other in a large orchard of about a thousand Oldenburg trees set out in 1917.

In the small planting, 135 of the original 156 Oldenburg trees were left in 1925 and 1926. In 33 of these no cankers had ever been found, and from the other 102 trees about 114 cankered limbs had been pruned out and about 561 cankers shaved off since this work was started in 1922. In 1922, about 74 cankered limbs and 201 cankers were removed from a total of 66 trees. In 1923, 18 cankered limbs and about 154 cankers were removed from 62 trees, in 21 of which infection had not been previously detected. There were 19 cases of marginal renewal of fungous growth about old cuts, representing about 9 per cent of the old cuts. In 1924, 9 cankered limbs and 43 cankers were removed from 26 trees. In 1925 and 1926, 13 cankered limbs and 112 cankers were removed from a total of 61 trees, in 14 of which the disease had not been previously noted. However, 46 per cent of the 88 trees previously operated upon were free from infection. There were 32 cases of renewal of mycelial growth about old scars, usually marginal and at the side, occasionally within the scar. These represented about 8 per cent of the cuts previously made.

[1] Contribution from the Department of Botany, Purdue University Agricultural Experiment Station, Lafayette, Ind.

[2] The writer desires to acknowledge his indebtedness to Prof. H. S. Jackson for advice and to Mr. R. A. Simpson, Mr. Ivan Cushing and others in the Simpson Orchard Co., Vincennes, Ind., for cooperation and assistance.

[3] Gardner, Max W. Origin and control of apple blotch cankers. Jour. Agr. Res. 25: 403–418. 1923.

The great majority of these cankers were the result of infection occurring before the campaign was started, and those found during the later years were invisible or overlooked during the earlier inspections. These results show the necessity of annual repetition of the process and emphasize the advisability of beginning the spraying and canker excision as soon as the orchard is set out rather than to give the disease three or four seasons in which to gain a foothold. The marginal renewal of mycelial growth about some of the cuts shows the importance of extending the cut well beyond the limits of the brown, discolored tissue, especially at the sides of the canker, since the mycelium tends to encircle the limb rapidly. It is important to remove all of the diseased tissue, but the cankers are shallow and can be shaved off without injury to the cambium.

Many of the cankers are difficult to detect, especially those on spurs, in crotches, and in the roughened, wrinkled bark about the bases of spurs. If a shallow cut is made with the knife, infection in such regions may be readily recognized by the brown discoloration of the outer bark tissues. Canker detection is best accomplished early in the spring before foliage and spray material interfere. The numerous short spurs on the interior of the tree are very likely to be infected and, being worthless, might as well be pruned out.

The proof of the effectiveness of this campaign was obtained when the orchard came into bearing in 1925. The special Bordeaux blotch sprays, which are put on usually two, four, and six weeks after petal-fall, had been applied annually since 1921, and in 1925 were omitted from a block of 68 trees comprising the eastern half of this orchard. After the petal-fall spray of lime-sulfur for scab control, only lime and lead arsenate were used. On July 10, shortly before the fruit was picked, all of the fruits on and under the 64 trees which bore fruit, 6,912 apples in all, were examined and no blotch lesions were found. Even though 1925 was a very mild blotch year because of the drouth in May, abundant infection occurred in older unsprayed trees in the vicinity; and in spray tests at Mitchell, 60 miles to the east, 85 per cent of the apples in an unsprayed check tree were infected.[4] Therefore the non-occurrence of fruit infection in the unsprayed block was highly encouraging.

In 1926 another crop of fruit was produced and the blotch sprays were again omitted from the same block of 68 trees. On July 20 the fruit from 52 of these unsprayed trees was picked and left in crates under the trees, where it was graded for blotch infection. The fallen fruits and the immature fruits on the trees were also inspected. In all, 11,673 apples were

[4] Gardner, Max W., Laurenz Greene, and Clarence E. Baker. Spraying tests for the control of apple blotch. Trans. Ind. Hort. Soc. 1925: 134–147. 1926.

inspected, and no blotch lesions were found. The 1926 season was much more favorable to blotch infection than that of 1925 according to the results obtained in spraying tests at Mitchell. Therefore the perfect freedom of the fruit from infection in the unprotected trees, 49 of which had once contained cankers, indicated that the sources of infection had been eliminated.

In the large orchard set out in 1917, the work of cutting out the cankers was begun in 1922 and was carried out by orchard men under the able direction of Mr. R. A. Simpson. The Bordeaux blotch sprays had been applied annually since 1920. A good crop was produced in 1925, and on a half row of 21 trees, 16 of which showed canker cuts, no blotch sprays were applied after the one applied two weeks after petal fall. Since tests carried out at Lafayette by E. J. Kohl showed that blotch infection occurred very late in 1925, the fruit on these trees was actually unprotected during the infection period. Just before the crop was harvested, 5,758 fruits on and under these 21 trees were examined and no blotch infection was found.

This orchard bore heavily again in 1926 and, after a lime-sulfur spray at petal fall, all of the Bordeaux blotch sprays were omitted from the same row of 21 trees. On July 21, 8,173 fruits on and under these trees were examined for blotch and only one lesion was found. These results indicate that canker eradication which had been started as late as five years after planting and which had been performed entirely by orchard men was remarkably successful.

The freedom of the fruit from infection in these unsprayed blocks for two years is considered to be very good evidence of the effectiveness of early canker prevention and eradication. How much might have been accomplished by the sprays alone had the cankers not been cut out is not known. However, the cankers are long-lived, and it was found in spray tests at Mitchell that three consecutive years of spraying did not eliminate the sources of infection in older, badly cankered trees.

Furthermore, the freedom of these unsprayed plots from infection is interpreted to indicate that, unlike the apple scab fungus, the blotch fungus is not usually disseminated long distances or from orchard to orchard by means of wind or other natural agencies and that its presence or absence in an orchard is largely determined by its presence or absence in the nursery stock originally set out.

Because Oldenburg nursery stock is so commonly infected and because the cankers increase so rapidly in this variety, its widespread use as a temporary filler between the permanent rows is believed to be responsible for the introduction of blotch into many orchards. Therefore it is important to start early to combat the blotch menace in this variety. A timely and thorough effort to eliminate the cankers will render the disease very easy to con-

trol by the time the trees come into bearing, and may possibly permit the ultimate omission of the special blotch sprays.

In summary it may be said that the effectiveness of blotch canker eradication in young apple orchards has been demonstrated by the freedom from infection of the fruit in blocks of trees left unprotected by the blotch sprays for two years.

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A MODIFIED METHOD OF DELINTING COTTON SEED WITH SULPHURIC ACID[1]

C. D. SHERBAKOFF

INTRODUCTION

The delinting of cotton seed with concentrated sulphuric acid has been strongly advocated for some time by workers at various Southern experiment stations interested in cotton culture. The method, apparently first used by J. F. Duggar[2] and outlined by F. M. Rolfs,[3] consists in covering the seed with concentrated commercial sulphuric acid and stirring the seed continuously for 10 minutes. The excess acid is then drained off and used again, the process being repeated until the acid becomes too thick, which happens when it is used for the third or fourth time. After the seed is treated, it is thoroughly washed in running water for about 20 minutes, or until the disappearance of the acid taste. The seed is then spread out to dry.

The advantages of the delinting of cotton seed are as follows. First, certain fungi and bacteria parasitic on the cotton plant, such as those causing cotton anthracnose, wilt, angular leaf-spot, and some forms of damping-off, are not infrequently carried on the surface of the seed. When there is lint on the seed, the common chemical disinfectants are not quite effective. The treatment with sulphuric acid destroys not only the lint but also the spores of fungi and bacteria on its surface. Delinting therefore decreases some of the diseases and practically controls others, as is claimed in the case of angular leaf-spot. Second, the delinted seed is easier to handle in planting, and therefore its use would result in economy of both labor and seed. Third, the treated seed absorbs moisture more easily from the soil, and hence germinates more quickly, at least under conditions of sufficient moisture.

Brown and Gibson,[4] discussing the present status of the treatment, say, "Until the present time, so far as the writers are aware, the method de-

[1] A brief, popular paper, based on the same experiments, was published as Circular No. 3 of the Tenn. Agr. Exp. Sta., 1926.

[2] Duggar, J. F., and E. F. Cauthen. Experiments with cotton. Ala. Agr. Exp. Sta. Bul. 153. 1911.

[3] Rolfs, F. M. Angular leaf-spot of cotton. S. Carolina Agr. Exp. Sta. Bul. 184. 1915.

[4] Brown, J. G., and Frederick Gibson. A machine for treating cotton seed with sulphuric acid. Ariz. Agr. Exp. Sta. Bul. 105: 381–391. 1925.

scribed by Duggar for delinting cotton seed is the only one that has been published. The most serious objections to this method are the slowness of the process, which involves considerable time and labor, and the danger accompanying the handling of concentrated sulphuric acid in open vessels. These two considerations have prevented the adoption of the sulphuric acid treatment to such an extent that it is seldom used except by experiment station workers.'' For these reasons they designed a machine which ''delints the seed quickly and satisfactorily in large quantities at a comparatively low cost,'' the reference being to the cost of labor and the cost of the machine when large quantities of seed are treated. However, the principles of the treatment—covering the seed with strong acid, draining the acid to be used again, and afterward washing the treated seed—are left as in the original Duggar method. Therefore the cost of the treatment, so far as the acid is concerned, is not reduced by the use of the machine. Nor is the necessity for subsequent washing of the treated seed overcome.

While entirely agreeing with Brown and Gibson that the slowness of the treatment without the machine and the dangers involved in the handling of concentrated sulphuric acid in open vessels are serious objections, the writer considers that one of the chief objections also is the large amount of sulphuric acid needed for the treatment. This objection was of course not so serious with Brown and Gibson, when the cost of their acid was considered as $16.00 per ton, or 0.8 cent per pound. Under ordinary conditions, and especially when the machine for the treatment is not available, the cost of the acid is by no means small. For instance, the writer's most recent information shows that acid in carboy lots is 6 cents per pound, or, on the basis of Brown and Gibson's figures, the cost of sulphuric acid for the treatment of a quantity of seed sufficient to plant an acre in Tennessee would be, not 14 or 15 cents, but nearly $1.00, in addition to the cost of the machine and labor. To the writer it has always seemed that the amount of acid required by the original method was excessive and could probably be materially decreased by using just enough to delint the seed properly, avoiding the excess of acid which accompanied the method. In this way is eliminated also the draining off of the excess acid.

There are, of course, objections to the washing of the seed. It involves an additional handling of sulphuric acid, though diluted; it necessitates the subsequent drying of the seed, with all that this involves; and finally, in spite of instructions, it is probably seldom that the washing is sufficiently well done, and as a consequence the seed is injured. It is evident that instead of the acid being washed off it could be neutralized by an application of the proper substances. It was doubtful, however, whether such treatment would be practicable.

To determine the above questions the author, early in 1926, undertook certain experiments, the results of which are recorded here.

THE AMOUNT OF CONCENTRATED SULPHURIC ACID REQUIRED IN THE STANDARD METHOD

In the delinting of cotton seed by covering it with concentrated sulphuric acid, the writer found, first, that the same acid could be used four times, after which it was too thick for further use; second, that one part of sulphuric acid will treat six and one-half parts, by volume, of cotton seed.

THE MINIMUM AMOUNT OF CONCENTRATED SULPHURIC ACID NEEDED FOR DELINTING

Experiments showed that the minimum amount of concentrated sulphuric acid required for proper delinting is one part of sulphuric acid to seventeen parts, by volume, of seed. For the delinting, measure off seventeen parts of cotton seed and add one part, by volume, of concentrated sulphuric acid; then stir continuously for 5 or 10 minutes. The amount of sulphuric acid at first appears quite insufficient, but after a minute or two of thorough mixing the seed becomes well covered with acid, and delinting is completed after the acid is allowed to stay on the seed for from 15 to 20 minutes. Sixty minutes of contact with the acid failed to injure the seed.

DELINTING WITH DILUTED SULPHURIC ACID

By testing different dilutions of sulphuric acid, the writer found that one part of concentrated sulphuric acid diluted with five parts, by volume, of water, and one part of this diluted acid added to ten parts, by volume, of cotton seed, will effectively delint the seed if the mixing is thorough, so that the acid will be evenly distributed over the seed. But the seed must be spread in a thin layer, in a dry place, and left for about seven days. Seed thus treated with diluted sulphuric acid was kept in the laboratory for over a month, and for a few weeks in the plot barn, without any injurious effect on germination. Various other dilutions and amounts of diluted acid were also tested, but the method given was found to be entirely effective and at the same time most economical.

SUBSTITUTION OF WASHING OF THE DELINTED SEED WITH A NEUTRALIZING SUBSTANCE

Only the liming of cotton seed after the treatment with sulphuric acid was tested. It was found to give as good results as a very thorough washing—no matter whether the seed was delinted by the standard method (covering with sulphuric acid), or with the minimum of sulphuric acid (one

part to seventeen parts of seed), or by being treated with 1:10 diluted sulphuric acid, at the rate of one part to ten parts, by volume, of the seed. In these tests sufficient air-slacked lime was used to cover the seed thoroughly.

THE EFFECT OF THE TREATMENTS ON THE SEED

The cotton seed delinted by the three methods, and subsequently either washed or limed, was germinated in the greenhouse. There was no difference in the time of germination among the different treatments or the checks. There was apparently a difference in favor of the treatments as compared with the checks in regard to the amount of blighting of the seedlings. No noticeable difference was found, however, among the different treatments in this respect. Cotton seed, one and two years old, treated with the diluted sulphuric acid, part of it washed and part limed, was tested in 1926 on a fairly large scale in the field.[5] This test showed neither injury nor benefit from the treatments. It should be pointed out, however, in this connection that the moisture condition of the soil at planting time was exceptionally good; that the seed used was of high germination and relatively free from diseases; and, finally, that the season was rather unfavorable for either angular leaf-spot or anthracnose. In other words, the checks showed a remarkably rapid germination of the seed, an excellent stand of the plants and very little anthracnose and angular leaf-spot on the plants during the season. The treated plots were at least as good. Only with a less favorable condition for seed germination, poorer seed, and a season more favorable for the development of diseases, could the test give a dependable indication as to whether the treatments are beneficial, and to what extent. The literature on the subject leaves no doubt of the benefit of delinting.

COMPARATIVE ECONOMY IN SULPHURIC ACID REQUIRED FOR THE DIFFERENT METHODS OF DELINTING

As previously stated, the standard, or Duggar's, method of delinting cotton seed with concentrated commercial sulphuric acid requires one part of acid to six and one-half parts of cotton seed. Delinting by the addition of the minimum amount of acid requires one part of acid to seventeen parts of seed, and the method of delinting with the diluted acid requires one part of the concentrated acid to sixty parts of seed—all of the proportions being by volume for both the acid and the seed. These proportions, when calculated on the basis of weight—the specific gravity of the concentrated acid being taken at 1.84 and the weight of one bushel of untreated seed at 32 pounds—are as follows: for the first method, 1 pound of the acid to 1.8

[5] In cooperation with Professor S. H. Essary, Botanist of the Tennessee Agricultural Experiment Station.

pounds of seed; for the second method, 1 pound of the acid to 4.6 pounds of seed; and for the third method, 1 pound of the concentrated acid to 16.1 pounds of seed.

CONCLUSIONS

The experiments in the delinting of cotton seed show that the most economical treatment is that with diluted sulphuric acid, which effects a saving of 89 per cent of the acid as compared with the standard method. If for any reason treating with strong acid is preferred, the treatment could be given with the addition to the seed of only the necessary amount of concentrated acid, or one part to seventeen parts, by volume, of seed, which requires 60 per cent less of the acid than the standard method.

After treatment by either method the seed can safely be limed instead of washed.

SUMMARY

The experiments here reported show that the standard, or Duggar's, method of delinting cotton seed with concentrated commercial sulphuric acid requires ten times as much acid as is needed when the delinting is done with diluted acid by the method devised during the experiments; and that the standard method requires two and one-half times as much sulphuric acid as is necessary when the acid is added to the seed in the minimum efficient amount, which is one part to seventeen of the seed, by volume.

None of the three methods of delinting, when properly carried out, injures the germination of the seed.

Liming the seed after delinting can conveniently and safely replace washing in any of the methods.

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PHOTOGRAPHING LIVING CONIDIA MOUNTED ON AGAR[1]

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In my studies of Fusaria I find that one of the most difficult parts of the work, and the part that takes the most time, is making good illustrations of the conidia. Ordinarily the illustrations are in the form of camera lucida drawings. As a rule, drawings have to be made from living material examined under an oil-immersion lens. The drawings, even for a person of experience and ability, require much time. Moreover, they unavoidably reflect too much of the individual's interpretation, which may render very difficult a proper comparison between the drawings made by different persons. Finally, it must be acknowledged that in many cases the drawings are so poor as to be of almost no practical value for the purpose intended. There is therefore a long-felt need of some method to replace or supplement that of drawing, which would give a true picture of the conidia and also save some of the drudgery and time. The use of a photographic process for this purpose naturally suggested itself, and, as a matter of fact, was employed by various workers. Some of them, Morris and Nutting,[2] for example, clearly realized the importance of the use of photomicrographs.

As ordinarily made, however, good photographs of the condidia in a drop of water are very difficult to obtain. The difficulty lay primarily in the fact that the conidia would not remain still for a sufficient length of time to admit proper exposure. Besides this, the conidia in water always occupy different planes and are turned in different directions, so that at best comparatively few of them can be found in focus without crossing others or being too crowded. Even when there is a minimum of water under the cover glass, and when the edges of the cover glass are well sealed with paraffin or a similar substance, the conidia exhibit some movement, especially the Brownian in the case of small conidia. When using water one is never sure that the conidia will remain stationary for the time required for a proper exposure.

Therefore, in order to utilize fully the advantage of the photographic method, it was necessary in mounting conidia to use some substance that

[1] The paper, under a slightly different title, was presented at the Sixteenth Annual Meeting of the American Phytopathological Society, Washington, D. C., Dec. 30, 1924, to Jan. 1, 1925. See "Use of agar blocks for photographing living spores." Phytopath. **15**: 1. 1925.

[2] MORRIS, H. E., and GRACE B. NUTTING. Identification of certain species of *Fusarium* isolated from potato tubers in Montana. Jour. Agr. Res. **24**: 348–349. 1923.

would be free from the objections mentioned. In other words, instead of a drop of water there should be used a transparent, solid substance, with a minimum of free moisture to keep the conidia in their original turgid condition and exclude the air around them, and at the same time be sufficiently firm to keep the conidia in place. A clear 2–3 per cent agar, as ordinarily used in mycological cultural work, is such a substance.

The agar for this purpose was first used in a manner similar to that followed in some laboratories for the examination of spore material; *i.e.*, small pieces were cut from a poured petri dish. The use of agar in such form gives satisfactory results, as far as holding the conidia in a stationary position is concerned. But, owing to the uneven thickness of the piece of agar, it is almost impossible to find a sufficiently large field with all parts in focus at the same time. For this purpose agar blocks of even thickness are required so that both surfaces will be parallel to that of the cover glass upon which the conidia are mounted. Such agar sheets or blocks are readily prepared when a series of slides are used as a mould. The slides at the ends are kept separate by the insertion of other slides, preferably about ½ mm. in thickness, and the whole placed on edge over a clean glass plate. To make sure that the agar sheets will be of the same thickness throughout, the thin slides are broken in two and the halves of the same slide inserted between the ends of the separating slides. Before pouring the agar into the spaces between the slides it should be cooled down to a point near solidification. At first only a small amount is poured; when that becomes hardened, a little more is added, and so on until the filling of the mould is completed. After the agar is thoroughly hardened, the end halves of the broken slides are pulled out, and the remaining slides, with the agar, are stored in a moist chamber for protection against rapid drying and dust. In preparation for photographing the conidia, the top slide is carefully taken from the agar sheet, and the agar cut once lengthwise and four times across, so that each sheet gives ten blocks for the mounting of the conidia. Three per cent water agar, cleared with the white of an egg, and filtered, is about the best for this purpose.

An excellent mount is obtained when a small mass of conidia is first placed on a cover glass in a droplet of water, or a very diluted stain, such as safranin, and evenly smeared over it. The conidia on the cover glass are allowed to dry almost completely, until the surface has a dull appearance, and are then turned down over the agar block on the slide. The drying of water, or of the dilute stain, draws the conidia into an even, single layer in which they are often arranged side by side, as if by hand (Fig. 1). This arrangement usually is undisturbed when the cover glass is carefully placed over the agar block, and it allows one to select for the photograph a field in which a considerable number of conidia over a comparatively small

area are in a fine position to show clearly their true and detailed morphology.

The agar blocks keep the conidia in the same relative position on the surface of the cover glass for a long time, so that even after many hours the material will be found in the same field. The drying of the agar block at the edges, however, affects the focus; and this should be taken into consideration when an oil-immersion lens is used and when the exposure is longer than 15 seconds. If the exposure is not longer than 30 seconds, the defect can be corrected by focusing to a point slightly deeper than that of the clearest focus. If a longer exposure is needed, either a readjustment of the focus should be made about every 15 or 20 seconds or the agar should be protected against drying by having its edges sealed with beeswax or paraffin.

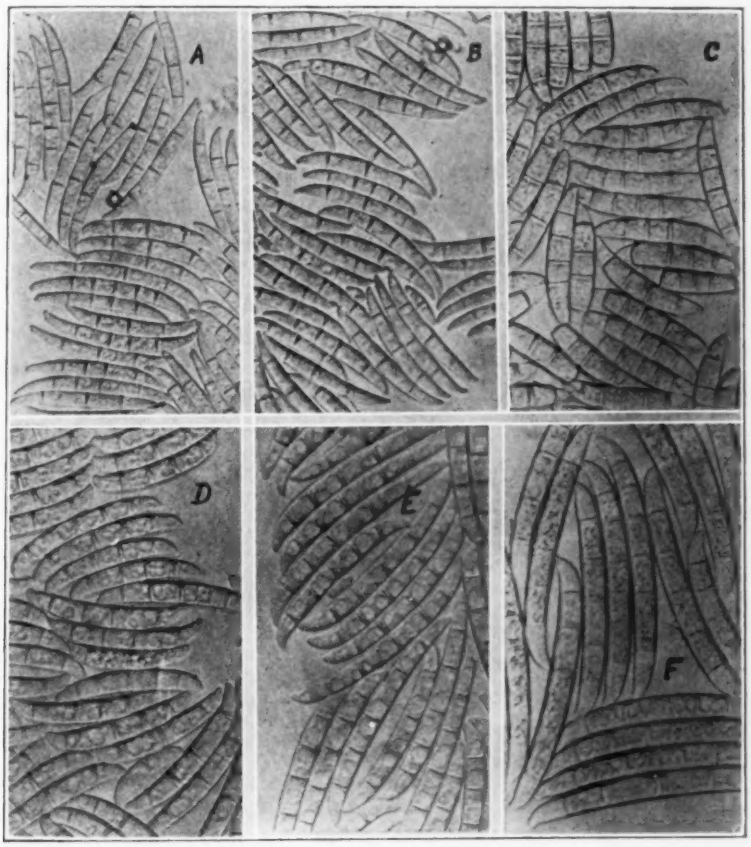

FIG. 1. A.—*Fusarium vasinfectum* Atk. B.—*F. oxysporum* Schl. C.—*F. culmorum* (W. G. Sm.) Sacc. D.—*F. solani* (Mart. pr. p.) App. u. Wr. E.—*F. martii* App. u. Wr. F.—*F. camartii* Carp. Magnification 500 times.

I find, however, that a slight modification in the use of agar answers the same purpose and is less troublesome than the agar block with sealed edges. The modification consists in use of agar in a cavity of a slide. During the last two years it was found that the common, thin micro culture slides with spherical concavity are just as easy to handle as those with straight walled cavities, and are much better because of their relative thinness. Into the cavity of culture slide is placed melted, clear agar, just a little more than is necessary to fill the cavity, and a common slide placed over it. The process is then repeated until enough slides for several days' use are obtained. The slides should be warm, so that the agar will not solidify too quickly. A little excess of agar in the cavity is necessary to rid it of the air bubbles. The agar in the cavity is used in the same way as the ordinary agar blocks. The agar dries very slowly so that the focal position of the conidia, after the excess of water is absorbed by the agar, is not noticeably changed for at least two or three minutes. This permits the use of a slow plate, which gives the best results when sharp outlines of the conidia are required. If a still further limit to the drying of the agar is desired, the edges of the cover glass should be sealed with beeswax or paraffin. Dr. H. W. Wollenweber uses the following method: a small beeswax candle is lighted for a very short time, then the flame is put out, and the edges of the cover glass are smeared with the point of the hot wick.

The method of using agar mounts in photographing conidia or any other small objects is very simple, is available to all, and requires no extra equipment. At the same time it gives such satisfaction that in many instances photomicrographs will, I am sure, entirely replace, or at least largely supplement, drawings, with gratifying results. In my extensive use of agar instead of water for mounting spore material, I have developed the habit, so that now, even for camera lucida drawings, I use it exclusively. Taking certain sanitary precautions, and using a good moist chamber with a sufficient amount of filter paper moistened with a weak solution of corrosive sublimate, I often was able to keep the agar slides for several weeks.

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CONTROL OF INTERNAL ROT OF CAPRIFIED FIGS

H. H. HANSEN

About six years ago a new disease of the fruit of caprified figs was noticed in California.[1] Since then the disease has spread so rapidly that in 1926 it was found prevalent in all the fig-growing sections of the State, entailing considerable loss to the growers by reduction in quantity and quality of both fresh and dried fruit.

The etiology of the disease has been thoroughly worked out by Caldis, who named the disease "Endosepsis" (internal rot).[2] He found the causal organism to be a variety of *Fusarium moniliforme* Sheld. to which he gave the name *F. moniliforme* Sheld. var. *fici* Caldis. He further found that the pathogene occurs in the interior cavity of both capri and edible figs and that it is transmitted only by the caprifying insect *Blastophaga psenes* L. (*B. grossorum* Grav.). He proved by experimentation that transmission is entirely mechanical, the fungous spores being carried only on the exterior of the insect.

In view of the above facts it seemed that the only way to control the disease would be to obtain caprifigs and insects that were free from the fungus, propagate them in isolated localities and gradually caprify all other caprifigs in the State from them. A state-wide search was made and several thousand caprifigs were collected and tested, by caprification under controlled conditions and by culture in nutrient media, over a period of two years, but clean colonies were not successfully established.

When the writer took over the control problem in July, 1926, it occurred to him that it might be possible to apply to the interior of the caprifig a fungicide that would be strong enough to kill the fungus without injuring either the fig itself or the insects still in the galls. In order to test out this possibility the following experiment was carried out. A large number of caprifigs (Mammone) were treated internally with the following fungicides: mercuric chloride 0.05 per cent, formaldehyde 0.2 per cent, Mercurochrome 0.1 per cent, Semesan 0.2 per cent, and commercial lime-sulphur solution 5.0 per cent. Injections were made with a hypodermic syringe through the eye of the fig, not less than three weeks after the fig had been caprified, so that the insects would be either in the larval or pupal stage and therefore well

[1] Caldis, D. Panos. A rot of the Smyrna fig in California. Science **52**: 161–162. 1925.

[2] Caldis, D. Panos. Etiology and transmission of endosepsis of the fruit of the fig. Hilgardia, Univ. of Calif. Press. [In press.]

down in the center of the gall. Treatment with the above mentioned fungicides had apparently no adverse effect on either the figs or the *Blastophaga*, as the figs matured normally and the insects emerged at the proper time.

Treated figs were removed from the trees and cultured on nutrient media at intervals of three weeks after treatment up to the time of maturity, when the emerging *Blastophaga* were caught and also cultured. An equal number of untreated figs, and *Blastophaga* from untreated figs, were cultured as checks. The following results were obtained: all the treated figs and the insects emerged from them were found to be free from *Fusarium moniliforme* Sheld. var. *fici* Cald.; all the untreated figs and the insects emerged from them were found to be 100 per cent infected with the fungus.

The above results seem to indicate that control may be effected economically by internal treatment of a limited number of caprifigs (preferably Mammone) with any of the fungicides which have been mentioned. By removal and destruction of all untreated figs, the source of infection would be eliminated and a clean strain of *Blastophaga* established.

This is a preliminary report on part of the work on fig diseases in general carried out under the direction of Professor Ralph E. Smith.

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FUNGICIDAL VALUE OF OIL SPRAYS

FRANK P. MCWHORTER

Since oil sprays have not been extensively experimented with by plant pathologists, the writer wishes to describe preliminary experiments which point to possibilities of their use in plant disease control.[1] In the vicinity of Norfolk, Virginia, where the humidity is relatively high, rose mildew caused by *Sphaerotheca pannosa* (Wal.) Lev. does great damage. It is almost impossible to grow successfully some of the more susceptible varieties of ramblers. Local conditions are such that commercial and home growers have found sulphur treatments very ineffective, in fact so unsatisfactory that this Station has ceased to recommend the sulphur treatment. This is explained in part by the frequency of rains at the time when mildew infections begin. Liquid Bordeaux is more effective when thoroughly applied, but most of the growers, especially the home growers, do not like to use it. With this situation in mind, the writer suggested the use of Volck concentrate mixture consisting of one pint of the concentrate to four gallons of water, the mixture to be applied coincident with the first appearance of mildew. This was tried by three growers who report remarkable control through its use. In each case three heavy applications were made at intervals of two to three weeks. The first application was made about six days after the mildew was first noticed. One large rambler which had not blossomed for three years, because of the disease, flowered abundantly in 1926. The grower believes that the treatment is responsible for the blossoming. One rose hedge about 110 feet long which has heretofore been unsightly and partly defoliated throughout the season has, apparently as a result of the treatment, kept its foliage and bloomed throughout the season. Untreated ramblers in the vicinity were heavily infected.

The exact nature of the fungicidal action has not been investigated. From general observations of the plants throughout the season the writer believes that the control evidenced is not entirely due to protection. One reason for this statement is that the majority of the patches of mildew covered with the oil failed to develop further. Obviously some smothering process is involved, but the possibility of a direct toxic action has not been studied.

[1] These experiments were undertaken upon information furnished by Mr. H. E. Woodworth, of the California Spray Chemical Company, who had noticed that certain fruit trees sprayed with emulsions prepared from "Volck" failed to develop mildew while those left as checks did.

Although the treatments were very heavy, no injury at all was observed for about four months after the first application. Leaf development was not checked, and most of the flower buds, even though heavily sprayed, opened normally. On September 20, some of the ramblers were showing some spray injury on the leaves, but not to an alarming degree. Since the plants usually keep their leaves but a short time after the first of October, the leaf injury factor will probably prove of little consequence. It is not comparable to a similar injury of citrus plants that sometimes follows too heavy applications of oil sprays, for in the case of citrus the leaves should stay on for a much longer time.

The results of the preliminary experiments mentioned above are so promising that we are planning extensive experiments during the fall and spring with mildew and other diseases which have comparable infection processes. This note is presented with the hope that other investigators may find occasion to experiment with the fungicidal properties of oil sprays.

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BOOK REVIEW

Citrus Diseases and Their Control. By Howard S. Fawcett, M.S., Ph.D., and H. Atherton Lee, M.S. Large octavo, 581 pages. 205 plates and figures. Fifteen colored plates. McGraw-Hill Book Company, 370 Seventh Ave., New York City. Price $5.00.

The senior author, Dr. Howard S. Fawcett, began his investigations on citrus diseases in Florida in 1905, and has given his uninterrupted attention to the subject since that time. In 1912 he transferred to California. In the meantime he has had the opportunity of making investigations in several foreign countries. The junior author, H. Atherton Lee, began plant pathological investigations in California in 1916, continued them in Hawaii, and later in the Philippine Islands. First hand field practise of the authors has enabled them to discard many useless and impracticable instructions and suggestions so frequently encountered.

This is the most lucid, accurate and comprehensive work that has been published on the subject. All known citrus diseases are included. The partially known or imperfectly investigated ones are noted and, as far as the literature permits, are discussed. The beginner in citrus pathology, in his efforts to extend the range of our knowledge, will find it an invaluable guide.

It differs materially from others that have been published on the subject in that the maladies are discussed from the viewpoint of the citrus tree rather than grouped artificially according to the classification of the causative agent. This manner of treatment makes the work especially helpful to the horticulturist and the practising plant pathologist. The authors deserve to be highly commended for having included only those remedies that practical experience has proved to be useful. Where trustworthy remedies are lacking, suggestions are made as to the directions in which experimenting may prove advantageous. The 78 pages of General Consideration contain information that is indispensable to every plant pathologist and to every citrus grower.

A novelty which will prove of great service to students in the colleges and to the practical horticulturist has been introduced in the form of a key for the determination of diseases, based on the region or part of the tree affected. The first division of this key serves to identify those maladies which affect the roots and trunk; the second, those which affect the branches; and the third, those which affect the fruits. The last section will prove an agreeable surprise to plant pathologists, as it illustrates and discusses fully the affectations to which fruit is subject after being removed from the tree, as well as those that may occur before clipping.

The value of the work has been greatly augmented by including a discussion of the affectations produced by animals other than insects, and by brief mention of some of the disorders caused by insects, which may readily be misinterpreted. A maze of difficulties which all students and even investigators encounter and stumble over is cleared up by the chapter entitled "Superficial Markings, Pustules, and Coatings." The pages on entomogenous fungi merit special mention. The authors strike out boldly and, justly, include such disorders as are caused by physical conditions and environment, as well as malnutrition, inherent genetic defects and physiological degeneration.

Over 130 maladies are discussed. The most important ones are illustrated, many by full page, well executed half-tones, and about 25 by colored plates.

This unequalled treatise will give a vigorous impulse to the study of citrus diseases the world over, since it gives the investigator authentic information on all known diseases of citrus, and thus leaves him free to direct his efforts to imperfectly known and new diseases. The bibliography, which includes 467 citations, is a perfect mine of information for the investigator. The rapid progress being made in citrus pathology is indicated by the fact that 57 per cent of the literature cited has been published since 1915.

The mechanical work is about as perfect as bookmakers' art can produce. The heavy calendered paper used makes the half-tones stand out well. A few typographical errors occur, but none have been noted that are worthy of comment. The 15 color plates are well executed and add greatly to the value of the work, as they illustrate diseases and phases of diseases that could not be correctly illustrated by black and white prints.

P. H. ROLFS,
Escola Superior de Agriculture e Veterinaria,
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